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# Mineral Development in Ontario North of 50°

Technical Paper #6

## Iron Ore

Dr. H. Strauss
and
Dr. E. T. Willauer

the ROYAL COMMISSION on the NORTHERN ENVIRONMENT

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Dr. E. T. Willauer

LAURENTIAN UNIVERSITY

1981

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However, no opinions, positions or recommendations expressed herein should be attributed to the Commission; they are solely those of the authors.


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# IRON ORE

# INTRODUCTION

This investigation deals with the mining of iron ore in the world between the years 1950 and 2004. In particular, any problem of its future supply is not one of a shortage of the raw material, iron ore, because it occurs in great abundance, but rather, it is a question of having sufficient real capital scheduled in place to meet the mounting demand of the iron and steel producers of the world. It is, of course, not impossible to make predictions about investment plans in the various iron ore-bearing countries beyond the 1980s, a point which need not be discussed again. As to the conditions and events of the iron ore industry in the 1980s the point will be argued that, due to a lack of adequate real capital formation earlier in this decade, demands to be placed upon this industry may prove larger than can be accommodated. With the rising prices of iron and steel commodities, any short fall in the supply of ore will, no doubt, be made up by iron and steel scrap of the secondary sector.

Since the productions of iron ore and steel will exceed 900 million and 1 billion metric tons respectively by the turn of the century excellent opportunities will present themselves for the chief iron ore resource holders of the world. Countries which may benefit from this demand are the U.S.S.R., Brazil, Canada, Australia and India as well as a

considerable number of countries on the African continent which are about to become prominent participants of the iron ore scene of the world.

However, it is also recognized that high grade ores will be preferred over lean ones by market-oriented suppliers of final commodities due to the mounting costs of energy, transportation, interest rates, etc. Closeness of users to the sources of supply of ore will also play an important role in the activities of the iron ore mining operations in the various regions of the world. Just as Australia is in an ideal supply location for such outstanding industrial iron users as Japan and China, so Canada will remain a chief iron ore supplier for the users in the United States, above all in the heartland of the North American steel industry around the Great Lakes. Nonetheless, the future performance and success of the iron ore industries of the various countries will be dependent in no small measure on the willingness of all types of governments of any country to support this important primary industry which is not in the habit of scoring high on the list price improvements for its products in comparison to prices of other and, mainly, scarcer metals.

This chapter is organized in the following manner: properties, qualities and substitutes of iron and the occurrence of its ores are the centres of interest of the first section, while the second attends to the consumption of the raw material

in the form of the output of the crude steel producers of the world and its main producing countries. Section III explores the performance of the mining of iron ores for the world and its main suppliers with special emphasis on Canada and Ontario as well as on the Canadian trade in iron ore products. World reserves of iron ores and their distribution are explored in Section IV which also is an attempt to assess actual and planned investment activities in the world's iron ore industries as reported at the beginning of the 1980s. Without a claim to be complete this survey tries to ascertain magnitude and sources of future iron ore supplies in the world in order to obtain, as much as is possible, a perspective of the competition facing the Canadian iron ore industry during the 1980s. After a review of the history of the prices of iron ore, pig iron and carbon steel plates, Section V proceeds with the presentation of the econometric projections until the year 2004 as regards prices and world output of iron ore and the production of crude steel. The study end with a summary of the main observations to be followed by several conclusions.

## SECTION I: THE ORE AND THE METAL

Iron is a silver-white metal element which is malleable, ductile and strongly attracted by magnets. It oxidizes in the form of rust when wet or when exposed in humid air and is easily susceptible to corrosion by many chemical elements.[1]

It is in the oxidized form of mineralization that most iron is found. If the metal content is sufficient such that the metal compound can be profitably extracted it becomes «iron ore». The most familiar oxide iron ores are hematite, siderite, goethite, turgite, and the bog and clay iron ores. Other ores are limonite, magnetite and chalybite.

In general, iron does not occur in active form in terrestrial rocks,but is quite common in meteorites. In normal form it occurs combined with a wide range of ores and in most igneous rocks. This most widely used of all metals is found in the earth's crust with a rate of occurrence of five percent.[2] It is one of the two most abundant metals, aluminum is the other. Yet, only large high-grade mineral deposits are the major source of iron. These deposits are located on all continents with the U.S.S.R., the U.S.A., Canada, Liberia, Mauritania, South Africa, China, India and Australia as the most important countries to be discussed with others in Section IV.

The uses of iron are so many, and so widespread that the name of this metal has been applied to describe an era of mankind:

'The Iron Age' in the history of civilization; it started 1200 B.C.[3] Unfortunately, the uses to which this metal has been put in the hands of men has also made it part of a more ominous expression characteristic of certain deplorable episodes in the history of civilization: blood and iron! The 20th Century might well be called the 'steel period' of the 'iron age'. In short, the uses of iron are too many to be listed and elaborated on in a study of this nature,[4] however tempting it is to the researchers to expand on this very idea!

Iron may be substituted in a number of forms and ways, but due to its abundance it is still the cheapest of substances with a great serviceability. If anything counts against its use, then, it is its great weight which invites substitution by two different substances. One of these lighter materials is aluminum which is also an abundant mineral. This substitute has the additional quality that it does not oxidize so easily but unfortunately its inherent strength is no match for that of iron. The other substances comprise the group of plastic materials. They are light in weight and very useful although their strength is not comparable to that of iron, even if plastic compounds do withstand normal weathering very well.

## SECTION II: CONSUMPTION OF IRON OR THE PRODUCTION OF STEEL

### World and Canada

All steel products come from iron ore. This is true even if some of the actual steel production uses steel and iron scrap. Obviously, at one time or other even these scrap components had their origin in the ore of iron. Therefore, steel production represents chiefly the consumption of iron ore. That there are other metals which enter into the production of steel and its alloys is true and interesting but lies outside the present discussion.[5]

World crude steel production rose from 188.6 million metric tons in the year 1950 to a high of 704.3 million metric tons in 1974 after which it settled back as two of the following years recorded declines in output over each of the preceeding years. Over the entire period, five years showed reductions in world crude steel output. They were the recession years of 1954 and 1958, and the years 1971, 1975 and 1977 (Table 1). Between 1950 and 1979, annual output rose by 295 percent. When comparing the averages of the first and the last five years the increase amounted to 222.6 percent; in short, annual crude steel output of the world tripled from an average of 213.62 to 689.04 million metric tons.

Canada's crude steel production displayed a similar though relatively stronger overall performance. From 3.07 million metric tons of crude steel produced in 1950, annual output rose to 16.08 million tons by 1979. This meant an increase between these two

TABLE 1

WORLD AND CANADIAN PRODUCTION OF CRUDE STEEL
FOR THE YEARS 1950 to 1979

| Year | Crude Steel World '000000 Metric Tons | Crude Steel Canada '000000 Metric Tons | Canada % |
|---|---|---|---|
| 1950 | 188.6 | 3.070 | 1.63 |
| 1951 | 209.8 | 3.237 | 1.54 |
| 1952 | 211.5 | 3.359 | 1.59 |
| 1953 | 234.7 | 3.734 | 1.59 |
| 1954 | -223.5 | - 2.898 | 1.30 |
| 1955 | 264.3 | 6.114 | 1.53 |
| 1956 | 282.9 | 4.809 | 1.70 |
| 1957 | 292.0 | - 4.598 | 1.57 |
| 1958 | -273.5 | - 3.955 | 1.45 |
| 1959 | 304.4 | 5.354 | 1.76 |
| 1960 | 346.6 | - 5.270 | 1.52 |
| 1961 | 351.2 | 5.886 | 1.68 |
| 1962 | 360.2 | 6.507 | 1.81 |
| 1963 | 386.6 | 7.427 | 1.92 |
| 1964 | 437.9 | 8.281 | 1.89 |
| 1965 | 458.9 | 9.134 | 1.99 |
| 1966 | 475.5 | - 9.090 | 1.91 |
| 1967 | 493.3 | - 8.794 | 1.78 |
| 1968 | 528.7 | 10.161 | 1.92 |
| 1969 | 572.5 | - 9.350 | 1.63 |
| 1970 | 593.9 | 11.198 | 1.89 |
| 1971 | -579.7 | -11.040 | 1.90 |
| 1972 | 626.4 | 11.859 | 1.89 |
| 1973 | 693.5 | 13.386 | 1.93 |
| 1974 | 704.3 | 13.623 | 1.93 |
| 1975 | -643.9 | -13.025 | 2.02 |
| 1976 | 673.3 | 13.290 | 1.97 |
| 1977 | -667.0 | 13.581 | 2.03 |
| 1978 | 715.7 | 14.904 | 2.08 |
| 1979 | 745.3 | 16.080 | 2.16 |

years of 423.8 percent or, on an average basis, a rise of 335.1 percent from 3.26 to 14.18 million metric tons as the respective averages for the same first and last five-year periods. In contrast to the annual crude steel performance of the world, a much larger number of years recorded declines in output over preceeding years. In all nine years saw declines in crude steel output in Canada, viz. 1954, 1957, 1958, 1960, 1966, 1967, 1971 and 1975. This implies a much greater irregularity in annual steel production in Canada than holds for the much more stable steel picture of the world. However, it has also to be pointed out, that,in turn, in 1979 Canadian steel production rose by one million metric tons over the output of 1978 when Canadian steel producers were known to be working very close to capacity.

The Canadian steel industry is still small by comparison to the world total and to the major steel supplying countries. This may be seen from the percentage share which the Canadian steel output holds in the world total. This has also been brought out in Table 1. Yet, this share has been steadily on the increase, especially after the recession year 1954 when Canada accounted for merely 1.3 percent of the world total. By 1979, its share was 2.12 percent reflecting a heroic up-hill struggle with Canadian steel output rising much faster than that of the world as a whole.

Distribution by Main Producing Countries

In 1950, the United States was the world largest producer of crude steel accounting for 46.58 percent of the world total.

By 1979, it was in second place with only 16.52 behind the U.S.S.R. which previously had held 14.48 percent in 1950 and which had moved to first place holding 20.56 percent in 1979.

In 1950 the United Kingdom had been the third most important steel producer accounting for 8.78 percent of the world's steel production. By 1979, it registered 8th on this scale with below three percent of the total. The third place, then, was occupied by Japan which had come up from behind from a seventh place in 1950 by increasing its annual steel output 23 (!) times in 1979 over that of 1950. Western Germany did not change position. It had been and remained fourth in line of the steel producing countries raising its output by a factor of 3.28. France, which had been in the fifth spot, emerged as the seventh largest steel producer in 1979 as her steel plants raised annual output 2.55 times during the period under study. It was China which held fifth place in 1979.

During the period from 1950 to 1979, Belgium moved from sixth position to 13th while Italy became the sixth largest steel producer in 1979. It had been number eleven in 1950. During that early year Canada had been in eighth place. Yet, inspite of its successful expansion, it counted only 10th on this scale in the year 1979. Czechoslovakia and Poland were nineth and tenth in 1950 respectively by 1979 the former was in eleventh position while the latter had become the nineth in the rank among the world steel producers.

In regards to the relative magnitude of the increases in annual steel production, it is South Korea which displayed

the most outstanding performance during this time. It expanded its crude steel production from a wartime output of 4,000 metric tons to 7,609,000 metric tons which represented an increase by 1,902 times (!) over its earlier output as indicated by the values in the last column in Table 2. This table also demonstrates how countries with initially small annual steel outputs advanced to become highly successful steel-making countries. Countries in point are Mexico, Brazil, Italy, the Netherlands, Spain, Poland, Romania, Australia and South Africa. It is, therefore, from such similar developing and industrializing countries that the big push in demand for steel of the world will come; and it is this demand for steel which ties in so closely with the supply and demand for iron ore.

Table 2

World Steel Production and
Distribution by Main Producing Countries
For the Years 1950 and 1979

| | 1950 | | mt '000,000 | 1979 | | mt '000,000 | Factor of Increase |
|---|---|---|---|---|---|---|---|
| World | | 188.6 | 188.6 | | 745.3 | 745.3 | |
| | Rank | % | | Rank | % | | |
| United States | (1) | 46.58 | 87.848 | (2) | 16.52 | 123.117 | 1.40 |
| Canada | (8) | 1.63 | 3.070 | (10) | 2.16 | 16.086 | 5.24 |
| Mexico | | 0.21 | .390 | | 0.94 | 6.985 | 17.91 |
| Brazil | | 0.42 | .789 | (12) | 1.86 | 13.874 | 17.58 |
| Austria | | 0.44 | .835 | | 0.66 | 4.915 | 5.89 |
| Belgium | (6) | 3.34 | 6.300 | (13) | 1.80 | 13.441 | 2.13 |
| France | (5) | 4.85 | 9.152 | (7) | 3.13 | 23.357 | 2.55 |
| Germany-West | (4) | 7.43 | 14.019 | (4) | 6.18 | 46.043 | 3.28 |
| Italy | (11) | 1.25 | 2.362 | (6) | 3.22 | 24.035 | 10.18 |
| Luxemburg | | --- | na | | 0.66 | 4.949 | -.- |
| Netherlands | | 0.26 | 0.490 | | 0.78 | 5.798 | 11.83 |
| Sweden | | 0.77 | 1.456 | | 0.64 | 4.731 | 3.25 |
| Spain | (12)2 | 0.43 | .815 | (15) | 1.63 | 12.163 | 14.92 |
| United Kingdom | (3) | 8.78 | 16.554 | (8) | 2.89 | 21.545 | 1.30 |
| Japan | (7) | 2.57 | 4.839 | (3) | 14.99 | 111.752 | 23.09 |
| China | | na | na | (5) | 4.62 | 34.430 | -.- |
| North Korea | | na | na | | 0.71 | 5.300 | -.- |
| South Korea | | | 0.004 | | 1.02 | 7.609 | 1902.28 |
| India | (12) | 0.77 | 1.461 | | 1.26 | 9.416 | 6.44 |
| U.S.S.R. | (2) | 14.48 | 27.300 | (1) | 20.06 | 149.500 | 5.48 |
| Poland | (10) | 1.33 | 2.515 | (9) | 2.60 | 19.400 | 7.71 |
| Czechoslovakia | (9) | 1.46 | 2.760 | (11) | 2.02 | 15.100 | 5.47 |
| Rumania | | 0.30 | 0.558 | (14) | 1.70 | 12.700 | 22.76 |
| East Germany | | -.- | -.- | | 0.94 | 7.000 | -.- |
| Australia | | 0.67 | 1.263 | | 1.09 | 8.136 | 6.44 |
| South Africa | | 0.43 | 0.816 | | 1.18 | 8.775 | 10.75 |
| TOTAL | | 98.4 | | | 95.26 | | |

## SECTION III: IRON ORE PRODUCTION

### World

Annual iron ore production of the world exhibited a continuously rising trend but recorded certain short-lived fluctuations. It rose from 116.8 to 506.6 million metric tons between the years 1950 and 1979, which amounts to an increase by a factor of 4.34. When measured in the average annual ore output of the first and the last five years of the period under study, the expansion was from 140.52 to 501.82 million metric tons which is equivalent to a three-and-one-half fold rise.

Some cyclicality is recognizable as the annual outputs for the years 1952, 1954, 1958, 1961 and 1967 were smaller than in each of the preceeding years. However, the time periods between the events of reduced annual ore production become larger as depicted in Table 3. For instance, the negative sign marking years of declining output at first shows up every first to third year; that is during the first decade. Later on, between 1961 and 1967, iron ore production climbs for five consecutive years before settling back to a lower level. The next upward movement continues from 1968 to 1976, i.e. for a total of nine consecutive years without any downward movement. The strength of the demand for iron ore is evident by the unchanged annual outputs for the years 1971 and 1972 - they amounted to 427 million metric tons in both years. Under a less boyant demand actual declines would have occurred in at least one of these two years. However, towards the end of the period under analysis, the momentum which had carried the iron ore industry of the world forward to such an extent

Table 3

Iron Ore Production of the World and Canada
and Distribution for Canada and Ontario
for the Years 1950 to 1979

| Year | ('000,000 Metric Tons) World | Canada | Distribution % Canada | Ontario | Ore Produced / Crude Steel Produced x100 |
|---|---|---|---|---|---|
| 1950 | 116.8 | 1.799 | 1.54 | 1.03 | 61.9 |
| 1951 | 143.8 | 2.335 | 1.62 | 0.99 | 68.5 |
| 1952 | (-)140.5 | 2.630 | 1.88 | 0.97 | 66.2 |
| 1953 | 159.2 | 3.248 | 2.04 | 0.89 | 67.8 |
| 1954 | (-)142.8 | 3.673 | 2.57 | 0.84 | 63.9 |
| 1955 | 174.5 | 8.125 | 4.66 | 1.25 | 64.8 |
| 1956 | 187.0 | 11.151 | 5.96 | 1.48 | 66.1 |
| 1957 | 202.9 | (-)11.113 | 5.48 | 1.20 | 69.5 |
| 1958 | (-)182.4 | (-) 7.847 | 4.30 | 1.10 | 66.7 |
| 1959 | 193.8 | 12.218 | 6.30 | 1.55 | 63.7 |
| 1960 | 256.6 | (-)11.140 | 4.34 | 1.07 | 74.0 |
| 1961 | (-)246.1 | (-)10.528 | 4.28 | 1.21 | 70.1 |
| 1962 | 252.3 | 14.148 | 5.61 | 1.31 | 70.0 |
| 1963 | 266.7 | 16.150 | 6.06 | 1.36 | 69.0 |
| 1964 | 301.1 | 20.766 | 6.90 | 1.45 | 68.8 |
| 1965 | 326.4 | 21.822 | 6.69 | 1.42 | 71.1 |
| 1966 | 339.9 | 22.474 | 6.61 | 1.32 | 71.5 |
| 1967 | (-)337.8 | 23.433 | 6.94 | 1.42 | 68.5 |
| 1968 | 368.1 | 27.349 | 7.43 | 1.71 | 69.6 |
| 1969 | 386.5 | (-)22.347 | 5.78 | 1.52 | 67.5 |
| 1970 | 421.3 | 29.187 | 6.93 | 1.57 | 70.9 |
| 1971 | 427.2 | (-)26.418 | 6.18 | 1.46 | 73.7 |
| 1972 | 427.3 | (-)23.822 | 5.58 | 1.53 | 68.2 |
| 1973 | 467.8 | 29.211 | 6.24 | 1.48 | 67.5 |
| 1974 | 513.8 | 28.722 | 5.60 | 1.31 | 73.0 |
| 1975 | 522.5 | (-)27.609 | 6.90 | 1.46 | 81.1 |
| 1976 | 523.4 | 34.081 | 6.51 | 1.18 | 77.7 |
| 1977 | (-)482.8 | (-)31.828 | 6.59 | 1.27 | 72.4 |
| 1978 | (-)474.2 | (-)25.925 | 5.47 | 1.30 | 66.3 |
| 1979 | 506.6 | 36.424 | 7.17 | 0.98 | 67.9 |

seemed to have petered out when the production records showed two consecutive years, 1977 and 1978, with declining iron ore outputs.

A definite relationship may be established between the annual output of iron ore and that of crude steel. It may serve as an indicator for the role which steel and iron scrap play in the iron and steel market. Normally, one would expect the significance of such scrap to be on the rise because ever-increasing amounts of iron and steel products see the light of day, leading to larger and larger quantities of scrap over time. However, such a hypothesis need not be born out. As Table 3 shows, the ratio of ore to steel production hardly changed for the first and last couple of years of the entire period. On the contrary, it appears to rise until 1975 when the highest value of 81.1 percent was noted. This high proportion was actually the result of a sudden drop in the production of steel of 8.6 percent (Table 1) whereas the iron ore production still rose though by 0.17 of one percent only.

Consequently, the variability of this factor is determined by the annual behaviour of both ore and steel production, which, in turn, are functionally related to a substantial number of other variables in the real world such as prices and changes therein of iron and steel, iron ore, iron products and substitutes, the cost of energy, interest rates and what not. Therefore, the relationship between the two variables is not as direct

nor as simple as generally suggested. In particular, it brings out the danger for the econometric application when such a ratio is used as a proxy for inventories.[6]

Canada

Canada's iron ore output expanded dramatically during the period under investigation. From an annual low production level of not quite 1.8 million metric tons, it rose to 36.4 million metric tons by 1979, a more than twenty-fold increase over this period of time. Considering the averages for the first and last five years which were 2.739 and 31,172 million metric tons respectively, the expansion factor measures an 11.8 fold increase, which,nonetheless, is quite remarkable.[7] Comparatively speaking,Canada's iron ore production rose 3.22 times faster than the output of Canadian crude steel. This strength as an iron ore producer is also reflected in the significance of Canada as a world producer. At the beginning of the period, Canada's world share was 1.54 percent (Table 3). By 1968, it stood at a high of 7.43 percent.

In the following years the Canadian importance as an iron ore producer in the world diminished slightly - i.e. in relative terms; but by the year 1979 again it held on to a 7.17 percent of the total world output of iron ore.

Ontario

Ontario's importance as a world iron ore producer is clear. It is small but still significant. In general, Ontario did not

participate in the immense expansion of Canada as a whole. In essence, the Province's rate of output expansion approximated that of the world, while two other Canadian provinces, viz. Newfoundland (Labrador) and Quebec, have to be credited for the Canadian success on the iron ore scene of the world.[8] At the end of the period, the significance of Ontario as an iron ore producer is strangely startling because, in world terms, Ontario's position dropped by 25 percent. A ten percent decline in tonnage extracted was accompanied by 89 and 55 percent increases of iron ore output in Newfoundland and Quebec respectively. In this sense, the year 1979 marked a low point of importance for the production of iron ore in Ontario reflecting the generally poor atmosphere surrounding the mining of iron ore in this province.

Main Iron Ore Producing Countries

The United States of America was the largest producer of iron ore in 1950 commanding 42.2 percent of the world total (Table 4). Since the end of the Second World War when it had become apparent that the high-grade resources of iron ore would be depleted early in the 1950s the United States embarked upon a policy of securing iron ore supplies from foreigh sources many of which still had to be discovered.[9] In this fashion, investment funds moved into other countries where iron ore outputs rose subsequently. At home the United

Table 4

World Iron Ore Production and
Percentage Distribution by Main Producing Country
For Selected Years Between 1950 and 1977

| World Production in '000 000 Metric Tons | 1950 116.8 | 1955 174.5 | 1960 256.4 | 1965 326.4 | 1970 421.3 | 1975 522.5 | 1977* 482.8 |
|---|---|---|---|---|---|---|---|
| Australia | 1.2 | 1.3 | 1.1 | 1.3 | 6.8 | 11.6 | 12.5 |
| Brazil | 1.2 | 1.3 | 2.5 | 4.3 | 5.9 | 14.1 | 11.7 |
| Canada | 1.5 | 4.7 | 4.3 | 6.7 | 6.9 | 5.3 | 6.6 |
| Chile | 1.5 | 0.5 | 1.5 | 2.4 | 1.6 | 1.3 | 1.0 |
| China | -.- | -.- | 11.8 | 6.6 | 5.7 | 6.2 | 6.7 |
| France | 8.3 | 9.4 | 8.5 | 5.9 | 4.2 | 2.9 | 2.3 |
| India | 1.7 | 1.6 | 3.9 | 4.4 | 4.7 | 5.5 | 5.5 |
| North Korea | -.- | 0.0 | 0.6 | 0.9 | 1.0 | 0.7 | 0.8 |
| Liberia | -.- | 6.7 | 0.8 | 3.4 | 3.8 | 2.6 | 2.5 |
| Mauritania | -.- | -.- | -.- | 1.2 | 1.4 | 1.1 | 1.0 |
| Mexico | -.- | 0.2 | 0.2 | 0.5 | 0.6 | 0.6 | 0.7 |
| Norway | 0.2 | 0.5 | 0.4 | 0.5 | 0.6 | 0.5 | 0.5 |
| Peru | -.- | 0.6 | 1.5 | 1.4 | 1.5 | 1.0 | 0.8 |
| South Africa | 0.6 | 0.7 | 0.7 | 1.1 | 1.4 | 1.5 | 3.4 |
| Spain | 0.9 | 1.0 | 1.1 | 0.8 | 0.8 | 0.8 | 0.9 |
| Sweden | 7.1 | 6.0 | 5.1 | 5.5 | 4.7 | 3.8 | 3.3 |
| U.S.S.R. | 20.5 | 23.9 | 21.1 | 24.8 | 25.2 | 24.4 | 27.2 |
| U.K. | 3.4 | 2.5 | 1.8 | 1.3 | 0.8 | 0.2 | 0.2 |
| U.S.A. | 42.2 | 30.7 | 18.7 | 15.4 | 12.7 | 9.4 | 7.3 |
| Venezuela | 0.1 | 3.1 | 4.9 | 3.5 | 3.3 | 2.9 | 1.8 |
| | 95.3 | 94.7 | 90.5 | 91.9 | 93.6 | 95.9 | 96.7 |

*preliminary

continued on p. 18

Table 4 (continued)

World Iron Ore Production and
Percentage Distribution by Main Producing Country
For Selected Years Between 1950 and 1977

| Rank | 1950 | 1955 | 1960 | 1965 | 1970 | 1975 | 1977* |
|---|---|---|---|---|---|---|---|
| 1 | U.S.A. | U.S.A. | U.S.S.R. | U.S.S.R. | U.S.S.R. | U.S.S.R. | U.S.S.R. |
| 2 | U.S.S.R. | U.S.S.R. | U.S.A. | U.S.A. | U.S.A. | Brazil | Australia |
| 3 | France | France | China | Canada | Canada | Australia | Brazil |
| 4 | Sweden | Liberia | France | China | Australia | U.S.A. | U.S.A. |
| 5 | U.K. | Sweden | Sweden | France | Brazil | China | China |
| 6 | India | Canada | Venezuela | Sweden | China | Canada | Canada |
| 7 | Canada<br>Chile | Venezuela | Canada | India | India<br>Sweden | India | India |
| 8 | Australia<br>Brazil | U.K. | India | Brazil | France | Sweden | South Africa |
| 9 | Spain | India | Brazil | Venezuela | Liberia | France<br>Venezuela | Sweden |
| 10 | South Africa | Australia<br>Brazil | Chile<br>Peru | Liberia | Venezuela | Liberia | Liberia |

*preliminary

TABLE 5

Country Ranking by Quality of Ore

| Rank | Grade of Ore Iron (%) | Countries |
|---|---|---|
| ( 1) | 68 | Brazil, Liberia |
| ( 2) | 66 | Finland |
| ( 3) | 65 | Mauritania, Norway |
| ( 4) | 64 | Australia, Venezuela |
| ( 5) | 63 | India |
| ( 6) | (60 - 65) | South Africa, Sweden |
| ( 7) | 61 | Canada, |
| ( 8) | 60 | U.S.S.R., Peru |
| ( 9) | 58 | Thailand |
| (10) | 55-60(56-58) | Morocco, Indonesia, Turkey |
| (11) | 56 | Korea, Malaysia |
| (12) | 54(53-55) | Japan, Algeria |
| (13) | 53 | Tunisia |
| (14) | 51 | Argentina |
| (15) | 50 | Egypt, Portugal, Spain |
| (16) | 44 | Italy |
| (17) | 43 | Greece |
| (18) | 39 | Germany-East |
| (19) | 35 | Yugoslavia |
| (20) | 33 | Bulgaria |
| (21) | 32 | Germany-West |
| (22) | 31 | Austria |
| (23) | 30 | Belgium, France, Poland |
| (24) | 29 | Luxemburg |
| (25) | 26 | Czechoslovakia, United Kingdom, Romania |
| (26) | 24 | Hungary |

United Nations, Monthly Bulletin of Statistics, September 1980 Vol. XXXIV, No. 9 p. 40-41.

Note: the figures relate to the approximate iron ore (products) content obtained from the ore in each country. The actual iron ore content may vary somewhat from period to period.

Stated attended to the exploitation of scale-economies through the large scale operations of both open-pit mines and hugh equipment, as the 1950s marked the beginning of high-grade pellet production from concentrating low quality taconite ores.[10]

Therefore, it was the ore demand in the United States which accelerated iron ore output in many countries, including Canada. This drive was supplemented by the domestic demands for iron ore coming from the iron and steel producers of the various countries. Results did not fail to materialize. By 1977 and 1979[11] the United States had fallen back into fourth place among the iron ore producers of the world, behind such countries as Australia and Brazil. It had lost 34.9 percentage points of the total distribution and it was the U.S.S.R. which had moved into first place around the year 1960. This particular country succeeded in raising its global output share significantly. (Table 4)

In 1950 France had been the third most important country in the production of iron ore, but this importance subsided. From 8.3 percent of the world total her share fell to 2.3 percent in 1977. France found herself in 11th place.

Sweden, famous for its iron ore production, experienced a similar fate. From fourth place in 1950 with 7.1 percent of the world total of ore production, it managed to hold on to nineth place in 1977. The United Kindgom underwent an even more severe experience. At one time it produced 8.3 percent of the world's iron ore. By 1977 and 1979[12] its ore output amounted to a mere 0.2 of one percent.

In short, the world structure of iron ore production changed substantially as more and more foreign - and mainly high-grade - mines were opened up. At the same time, it has to be realized that the demand pressure did not come any longer from the United States alone. Japan in Asia and the industrial giants of Europe accelerated the exploitation of iron ore in the world. They all joined in the search for iron ore and they proved willing to invest substantial sums in these necessary projects. Thus, the USSR(1st)Australia (2nd), Brazil (3rd), U.S.A. (4th), China (5th) and Canada (6th) were the main ore suppliers of the world. They were closely followed by India, South Africa, Sweden and Liberia. Other important ore-supplying countries were Mauritania, North-Korea and Venezuela.

There is no doubt that the size of the various ore deposits in these countries play a role in their successes. But the quality of the deposits is of even more critical importance. This is brought out in Table 5 which presents the shipping grades of the ore products of the various countries. The ten top producers of ore are all within the ten best iron ores recognized in the world. In particular, nations with quality reserves have moved up very quickly through the ranks of the producing countries. This means that the higher the grade, the lower the quantity of waste that has to be handled from mine to main base product and the lower the cost of the iron. However, there are other aspects in the determination of the

cost processable ores which remain outside this discussion.[13]

Canadian Trade in Iron Ore and Basic Iron and Steel Products

The following exposition attends only to the trade in iron ore. However, additional tabulated information as to the extent of exports and imports of basic iron and steel products is offered in the Appendix to this shapter to permit a more integral trade picture of the crude part of the iron and steel industry.

The overall structure of such exports and imports is set out in Table 6 which relates to the physical quantities traded in terms of metric tonnages and their distributions. This picture clearly brings to the forefront two things: the first is the predominance which exports of raw iron and steel products hold over their imports for the years 1977 to 1979. Subsequent ratios were observed.

The exports to imports of raw iron and steel products provided the following factors:

1979: 6.94

1978: 5.86

1977: 14.44

These factors, or ratios, mean that for each imported ton of iron products 6.94 metric tons were exported in 1979, 5.86 in 1978 and 14.44 in 1977. This speaks quantitatively for the overall net balances which in real quantities were 43.15, 28.00 and 43.37 million metric tons of iron products in the years 1979, 1978, and 1977 respectively.

Table 6

Canadian Iron Export and Import Structure for the Years 1977 - 1979

By Commodity Item

| Commodity Description | Commodity Item | Exports 1979 | Exports 1978 | Exports 1977 | Imports 1979 | Imports 1978 | Imports 1977 |
|---|---|---|---|---|---|---|---|
| | Volume | 50,421,181 | 33,750,810 | 46,600,458 | 7,269,663 | 5,756,840 | 3,226,603 |
| | | % | % | % | % | % | % |
| Iron Ore, Direct Shipping Grade | 251-04 | 8.11 | 8.65 | 6.67 | - | - | - |
| Iron, Concentrated | 251-08 | 47.92 | 41.49 | 45.68 | - | - | - |
| Iron Ore, Agglomerated | 251-12 | 40.72 | 43.61 | 43.96 | - | - | - |
| Iron Ore, N.E.S., incl. by-prod. | 251-16 | 0.13 | 0.86 | 0.38 | - | - | - |
| Iron Ore | 251-20 | - | - | - | 81.33 | 81.40 | 77.64 |
| Iron Scrap | 251-29 | 0.28 | 0.42 | 0.22 | 4.25 | 4.93 | 7.33 |
| Steel Scrap | 251-40 | 1.70 | 2.10 | 1.23 | 10.15 | 11.60 | 10.77 |
| Ferromanganese, incl. Spiegeleisen | 441-19 | 0.02 | 0.06 | 0.05 | 1.15 | 0.47 | 0.91 |
| Ferrosilicon | 441-39 | 0.08 | 0.18 | 0.10 | 0.27 | 0.18 | 0.28 |
| Ferro Alloys, N.E.S. | 441-99 | 0.01 | 0.03 | 0.01 | 0.10 | 0.30 | 0.53 |
| Pig Iron | 442-19 | 0.51 | 1.61 | 1.08 | 0.14 | 0.04 | 0.37 |
| Iron and Steel Powder | 442-27 | - | - | - | 0.06 | 0.07 | 0.14 |
| Sponge Iron and Primary Iron N.E.S. | 442-29 | 0.27 | 0.17 | 0.11 | 0.07 | 0.07 | 0.12 |
| Ingot Carbon Steel | 442-30 | - | - | - | 0.93 | 0.62 | 1.59 |
| Steel Ingots | 442-49 | 0.04 | 0.10 | 0.19 | - | - | - |
| Ingots, Alloy Steel | 442-55 | - | - | - | 0.06 | 0.03 | 0.03 |
| Blooms, Billets and Slab Carbon Steel | 442-60 | - | - | - | 1.31 | 0.09 | 0.11 |
| Blooms, Billets and Slab Alloy Steel | 442-90 | - | - | - | .17 | 0.20 | 0.17 |
| Blooms, Billets and Slabs Steel | 442-99 | 0.20 | 0.73 | 0.32 | - | - | - |
| | | 99.99 | 100.01 | 100.00 | 99.99 | 100.00 | 99.99 |

In financial terms, the balances were as follows:

Total Balance of Canadian Trade in Crude Iron and Steel Products Including Ores

($ Can. '000)

| Year | 1979 | 1978 | 1977 |
|---|---|---|---|
| Total | 1,133,743 | 760,940 | 1,106,821 |
| Iron Ore | 1,126,694 | 615,143 | 987,649 |
| Products | 7,049 | 145,797 | 119,172 |

Both, this balance as well as that provided for the trade structure in Table 6 tell quite unequivocally of the export dominance of iron ores. In 1979, the balance was 1.1 billion $ Can. which compares favourably with the balances obtained in the two previous years even if the improvement over that of 1977 is but 2.4 percent. However, it is also clear that the net export balance of ores is equivalent to 99.38% , 80.73%, and 89.23% of the overall dollar balances. The relatively low value of the year 1978 represents a steep decrease in the exports of iron ore because during this particular year a general excess of supply over the demand of iron ores existed in the world especially in the U.S.A.

Four ore categories make up the Canadian exports of iron ores: direct shipping grade, concentrated ores, agglomerated ores, and others. The direct shipping grade is crude merchantable material not requiring any or only minimal processing. By 1979, 4 million metric tons were shipped constituting 8.37 percent of the iron ore exports during that year. Much smaller quantities had been shipped in 1978 in turn marking a decrease over 1977.

Table 7 provides the basic information. Most of this ore (86%) went to the United States with the remainder absorbed by Italy (493,304 metric tons), Belgium-Luxemburg (214,234 metric tons) and Western Germany (40,340 metric tons).

Concentrated iron ores are usable ores produced by beneficiation plants in the form of coarse concentrates used for pellet feed. 24.2 million metric tons were exported in 1979 which was alomst one half (49.47%) of all iron exports. The output of this year represented a huge increase over the 14 million metric tons that were exported during the previous year. In turn,the exports in 1978 meant a substantial decline from the export level of 21.3 million metric tons achieved in 1977 (Table 8). Besides the more significant customer countries of the U.S.A., Japan, the U.K. and the Netherlands, other countries purchased concentrated iron ores from Canada. They were Australia, Belgium-Luxemburg, France, Western Germany, Italy, Portugal, Romania, the Philippines, Spain, and Yugoslavia.

Agglomerated iron ores are fine-grained concentrated ores of suitable natural ores which have been transformed into agglomerates for easier transportation and smelting. Depending on the process of agglomeration used the resulting iron ore products are pellets, sinter, briquets and various other forms of ore products.

The volume of shipments to abroad of agglomerates in the years 1979 and 1977 were almost the same with about 20.5

Table 7

Iron Ore, Direct Shipping Grade
(commodity 251-04)

| Year | Quantity (metric tons) Exports | Value ($'000) Exports |
|---|---|---|
| 1979 | 4,091,580 | 58,214 |
| 1978 | 2,918,213 | 32,050 |
| 1977 | 3,106,200 | 46,078 |

Exports 1977 - U.S. 86%
1978 - U.S. 86%
1979 - U.S. 83%

Table 8

Iron Ore, Concentrated
(commodity 251-08)

| Year | Quantity (metric tons) Exports | Value ($'000) Exports |
|---|---|---|
| 1979 | 24,159,739 | 450,582 |
| 1978 | 14,001,972 | 243,674 |
| 1977 | 21,289,231 | 341,300 |

Exports 1977 - U.S. 25%
Japan 20%
Neth. 19%
U.K. 15%
1978 - U.S. 26%
Neth. 19%
Japan 16%
U.K. 16%
1979 - Neth. 21%
Japan 20%
U.K. 17%
U.S. 16%

million metric tons annually each. Only the year 1978 had experienced a much lower export of agglomerates when 14.7 million metric tons were recorded in the export statistics (Table 9).

In 1979, these exports accounted for 42.03 percent of all iron ore exports products with the United States as Canada's most important customer country. The remainder went to the United Kingdom (1,995,224 metric tons)., the Netherlands (1,555,774 metric tons), Spain (582,527 metric tons), Western Germany (478,871 metric tons) and Belgium-Luxemburg (168,197 metric tons), and a small quantity went to Yugoslavia (28,504 metric tons).

The last of the categories of exported iron ore products -others- refers to those which have not been specified elsewhere and included also certain unspecified by-products. Their volumes were insignificant and in 1979, amounted to 0.13 of one percent (1978: 0.86%); this information may be derived from the figures in Table 6 and Table A1. In 1978, the total shipment stood at below 300,000 metric tons.

On the import side of iron ores into Canada, the behavioural pattern differs substantially from that of the exports. Most importantly, the quantities involved were much smaller even if they proved significant. As shown in Table 10 Canada's iron ore imports rose by 136 percent between 1977 and 1979. Even the year 1978 which was marred by a considerable drop in the exports of such ores, displayed a significant rise in imports by 2.1 million metric tons.

Table 9

Iron Ore, Agglomerated
(commodity 251-12)

| Year | Quantity (metric tons) Exports | Value ($'000) Exports |
|---|---|---|
| 1979 | 20,533,050 | 843,550 |
| 1978 | 14,719,498 | 496,862 |
| 1977 | 20,486,994 | 670,017 |

Exports 1977 - U.S. 89%
1978 - U.S. 85%
1979 - U.S. 75%

Table 10

Iron Ore
(commodity 251- 20)

| Year | Quantity (metric tons) Imports | Value ($'000) Imports |
|---|---|---|
| 1979 | 5,912,550 | 227,391 |
| 1978 | 4,685,843 | 167,650 |
| 1977 | 2,505,191 | 76,274 |

Imports 1977 - U.S. 83%
Brazil 15%
1978 - U.S. 82%
Sweden 9%
1979 - U.S. 85%
Brazil 13%

Naturally, one may be concerned about the imports of foreign ores into Canada because they may be interpreted as causing negative employment effects in the domestic iron ore industry. Fortunately enough, this does not seem to be the case for the year 1979 because an 11 million metric ton increase in domestically mined ore (Table 3) was recorded. However, this does not hold for the years 1977 and 1978 because these years displayed obvious declines in the output of Canadian iron ore mines. However, recent statistics of the Canadian Government indicate that this rising import trend has flattened out at least for the year 1980.[14,15] It should be noted that these imports come not only from the United States but from countries known for their high-quality ores. The countries mainly involved are Brazil and Sweden. And there is no doubt, that the Brazilian ores have a definite competitive advantage over Canadian ores which will affect the operations of the coastal and iron producers in Canada. At the same time it should also be clear, that the operations in the Great Lakes area are less subject to disruptive competitive inroads from Brazilian and other foreigh high-grade ores due to the additional cost of transporting these ores to the mills and foundries of the Great Lakes area, the heartland of the North American steel industry.

## SECTION IV: WORLD RESERVES AND ALTERNATIVE SUPPLIERS

Iron is an abundant mineral and there is essentially no iron shortage in basic mineralization. For the iron industry, however, only the higher grades of known mineral deposits and those probable to be discovered and of an economic quality are considered iron-ore resources. These iron ore resources amounted to about 195 billion metric tons in metal content according to a Table presented and discussed by Klinger.[16] They were based on an inquiry undertaken by the United Nations in the year 1969. By 1975 the time when Klinger's chapter in Mineral Fact and Problems was published, these iron ore figures had neither been adjusted for ore extracted nor for new discoveries. In Klinger's opinion there was no argument to the contrary that iron ore bodies were discovered faster than others were mined out. However, he did include the now famous Carajas deposits which had been discovered very early in the 1970s in Brazil but which had not yet been sufficiently assessed at the time of the UN survey.

Duncan R. Derry has produced an ore reserve survey in 1980[16]. Unfortunately, it is not comparable to the previous statistic because he measured the tonnage of ore and not the contained metal. Even if one applies the going ore grades to these values on a country by country basis the results are not satisfactory, as for instance in the case of

the U.S.S.R. The respective discrepancy has been set out in a footnote.[17]

In addition, seabed nodules, especially those found in the Atlantic Ocean, contain a relatively high percentage of iron. Should seabed mining become a reality, iron ore also will be extracted as a by-product of nickel, copper, and above all, manganese operations. Therefore, it is obvious that the iron ore reserves as stated in the literature are not a satisfactory reflection of the real iron ore reserves of the world! suffice it to say, it cannot be the purpose of this investigation to carry on in this direction since the determination of the real reserves is far beyond the scope of this modest endeavour. If anything may be done, then, it is to work from the base of an assumption. In this sense it would be quite reasonable to assume that the magnitude of iron ore reserves exceed the 200 billion metric ton mark. Furthermore, it may be reaslistically assumed that these reserves will grow through the discovery of new deposits simultaneously as iron is being mined, and with the rising price of iron which will turn previously known 'uneconomic mineralization' of iron into financially feasible ore deposits.

If anything is relevant, then, it is the distribution of the reserves. According to Klinger (Table 11) the U.S.S.R. with 26.5 percent is the largest holder of iron ores in the world followed by Canada and Brazil each with approximately

TABLE 11

Iron Ore Reserves in Billions of Metric Tons

| | Iron Ore Reserves Ore[1] | | Iron Ore Reserves Metal Content[2] | |
|---|---|---|---|---|
| | 1979 Short-run | % | | % |
| United States | 25.4 | 9.55 | 16.33 | 8.37 |
| Canada | 36.6 | 13.75 | 26.31 | 13.49 |
| Mexico, Central America, Puerto Rico | - | - | .54 | 0.28 |
| Brazil | 27.2 | 10.23 | 26.31 | 13.49 |
| Venezuela | 2.6 | 0.98 | 3.54 | 1.81 |
| Other | - | - | 16.42 | 8.42 |
| U.S.S.R. | 110.7 | 41.62 | 51.71 | 26.50 |
| France | 4.0 | 1.50 | 3.27 | 1.67 |
| Sweden | 3.4 | 1.28 | 2.72 | 1.40 |
| Other | - | - | 4.54 | 2.33 |
| South Africa | 3.0 | 1.13 | 2.72 | 1.40 |
| Liberia | 1.4 | 0.53 | 0.73 | 0.37 |
| Other | - | - | 3.81 | 1.95 |
| | 9.1 | 3.42 | 7.89 | 4.05 |
| | 6.1 | 2.29 | 6.44 | 3.30 |
| Other Asia (incl. Middle & Far East) | - | - | 2.72 | 1.40 |
| Australia | 17.8 | 6.69 | 18.14 | 9.30 |
| Other | - | - | 0.91 | 0.47 |
| All Others | 18.7 | 7.03 | - | - |
| | 266.0 | 100.00 | 195.05 | 100.00 |

[1] Duncan R. Derry, A Concise World Atlas of Geology and Mineral Deposits, Mining Journal Books (London, 1980), p. 96.

[2] F.L. Klinger, «Iron Ore», Mineral Facts and Problems 1975, U.S.B.M. (Washington), p. 529, Table 1.

the same distribution of 13.49 percent. The fourth largest iron ore resource holder is Australia with 9.3 and only, then, the United States with 8.37 percent. The next countries by line of importance are India with 4.05 percent, China with 3.3 percent, Venezuela with 1.81 percent, France with 1.67 percent, and Sweden and South Africa with 1.4 percent each. The more recent 'Derry Series' does not contradict this basic distribution although the positions of both Canada and the United States appear in a more favourable light (Table 11).

Alternative Suppliers

This subsection deals with actual and/or planned investments in the iron ore industry in the world. The basic reference for this discussion is again found in the reports of the Engineering and Mining Journal[18] which tabulates annually investment news of the various countries. The geographic regions covered are North and Central America, South America and the Caribbean, Europe, Africa, Asia as well as Australasia. About 21 countries are involved in this survey exceeding the number of countries listed in the basic reference as supplementary sources were consulted to present a more comprehensive picture than otherwise would have been possible.

North and Central America

| | | | |
|---|---|---|---|
| Mexico | Iron Ore Production | 1950: | 286,000 metric tons |
| | | 1979: | 3,985,000 metric tons[19] |
| | Crude Steel Production | 1950: | 396,000 metric tons |
| | | 1979: | 6,985,000 metric tons[20] |

Following Table 11, Mexico's iron ore reserves are not very significant in world terms. In that Table, its reserves have been aggregated with those of other countries of the region, and it is, therefore, difficult to say anything about the reserves without extending the scope of the investigation. Let us have a short glance at the general picture of the iron and steel industry of Mexico.

The production picture at the end of the 1970s was marked by a customary phenomenon of the time: underutilization of capacity.[21]

Mexico has an annual mining capacity of 13 million metric tons of iron ore and facilities for beneficiation of 11 million metric tons. By the year 1990 iron ore requirements for the Mexican steel indsutry is expected to run at 15 million metric tons annually. Three open-pit iron ore mining projects are envisaged to accommodate the expansion of the Mexican steel industry.

The Altos Hornos Company will raise its output at the La Perla Mine site by 35 percent, or by 800,000 to 3,100,000 metric tons. This investment project will also provide for

a modern way of ore transport which enjoys increased popularity in the world of iron producers: a slurry pipeline will be built 235 miles in length to supply the Monclava operations.[22]

The second project involves the Hylsa Company. It will open up a mine with a capacity to deliver 1.4 million metric tons of ore annually. Expected to operate in 1984, this mine will replace the El Encino mine. Here, too, a slurry pipe line may be included in the final project. Finally, there is the plan of the Sicartsa Company which is in the process of boosting steel output at Sicartsa II. Its existing mine as Las Truchas will expand production by about 70 percent, or from 3.5 million to 6 million metric tons. Target date of operation is 1984 as well.

This means that the net additions of these projects would enlarge the output of iron ore in Mexico by 3.3 million metric tons. It would provide considerable scope for the expansion of the Mexican steel industry especially in light of the recent underutilization of its capacity. Mexico would reduce the degree of dependence on imports of iron ore to satisfy the demand of its steel producers.

South America

| | | | |
|---|---|---|---|
| Brazil | Iron Ore Production | 1950: | 1,351,000 metric tons |
| | | 1979: | 40,579,000 metric tons |
| | Crude Steel Production | 1950: | 789,000 metric tons |
| | | 1979: | 13,812,000 metric tons |

The basic statistic demonstrates Brazil's great strength as an iron ore exporter. Figuratively speaking, Brazil is at a threshold of a virtual iron ore explosion. After the Conceicao project was put on stream in 1979 with the still unachieved goal to produce 28.5 million metric tons of iron ore fines and granules, the Compana Vale do Rio Doce - CVRD, a government corporation, is investing $103 million in the Timbopeba project near Mariana in the State of Minas Gerais. To be in operation in 1981, it will at first produce 7.5 million metric tons annually which is to be raised to 11.5 million metric tons later.

However, the main impetus in the area of iron ore production will come from the CVRD's mammoth project in Carajas in the State of Para. Originally, the project was in the hands of Amazonia Mineracao, a subsidiary of CVRD. However, recently this company was dissolved by presidential decree to divest it from its enormous power as it was about to outgrow the strength of its governmental parent company.[23] This strength stemmed from the resource base on which it could have drawn.

Early in the 1970s the full magnitude of this extraordinary ore body had been determined. With an ore reserve of (a) 16 billion metric tons grading 66.7 percent iron (10.672 billion metric tons of iron content) and a further 2 billion metric tons measuring 62 percent iron, a total

mineral deposit of 11.9 billion metric tons of iron content represented a huge ore reserve by any standard of comparison.[24] $3 billion are being invested to exploit this high-grade, polymetallic though mainly iron ore deposit. According to one source it will produce 15 million metric tons annually; and 24.5 million according to another.[25] Initially, $2.5 billion were planned for this project; $180 million for the mine, $160 million for a port and $2.15 billion for a railway 560 miles long.

Unfortunately, financing of such a mammoth capital project is not easy and frequently faces considerable difficulties. The Carajas project is no exception. One way to secure financing is to obtain contracts from other governments for ore purchases in the future and to raise funds on such contracts. So far, the following contracts appear to have been concluded:

| | |
|---|---|
| German steel companies | 6 million metric tons annually, |
| France | 3 million metric tons annually, |
| Other Countries | 2.5 million metric tons annually, |

Japan is expected to sign a 13 million metric tons contract with negotiations underway for undisclosed amounts with the U.S.S.R., Mexico, Belgium, and Iraque. The World Bank is expected to advance $300 million after 1983 with three offers received for the partial financing from:

| | |
|---|---|
| The World Bank | $300 million |
| European Economic Community | $500 million |
| Western Germany | $108 million |
| Japan | $300 million |

The sum total which has thus been secured by the beginning of the 1980s was about $1.2 billion.

It is also interesting to note that Brazil has expressed the hope for the construction of a pellet plant in Mexico. It would have the capacity to produce 3 million metric tons annually and would process Brazilian ores.

Other projects are in progress in Brazil. There is the Samitri Company. It intends to raise the output of its Algeria mine by 9.5 million metric tons annually from the earlier 2.5 million to 12 million metric tons. Besides, the M.B.R. will add a third ore dressing line at its Aquas Clara site with the purpose of raising the annual ore capacity from 12 million to 20 million metric tons.

Recently, world market conditions have forced Brazil to close out - with a loss in capacity - the operations of 2 million metric tons of pellets per year involving the pellet plant in Espirito Santo on the Atlantic coast.[26]

From an overall Brazilian point of view, the aim of the government of that country is to bring about self-sufficiency for its steel industry by 1988. To this end it has drawn up a steel Master Plan which calls for an investment of $11 billion. But the difficulty facing the completion of this grand design is that it would require an annual rate of growth of the gross national product of about 20 percent, which would be difficult even for the most prosperous of economies not to mention one which is plagued by rampant inflation. One thing is certain: there is no shortage of iron ore!

| | | |
|---|---|---|
| Colombia | Iron Ore Production | 1954: 35,000 metric tons |
| | | 1977: 460,000 metric tons |
| | | 1979: 300,000 metric tons (est. |

The steel industry in Colombia is small by any stretch of the imagniation. A lack of major iron ore reserves has only permitted the development of integrated steel works at Paz de Rio in Boyaca. This medium-sized plant produced 373,500 metric tons of steel and iron products in 1979.[27] Other, smaller plants equipped with electro-furnaces are located at Medellin, Cali, Bogota and Tunja and produce steel from scrap.[28]

This industry will receive a strong boost by Ferrominera S.A. with the planned investment of $74 million to build a plant to produce 250,000 metric tons of sponge - an iron ore product. In this fashion Colombia's steel output may reach 1 million metric tons eventually.

| | | |
|---|---|---|
| Chile | Iron Ore Production | 1950: 1,771,000 metric tons |
| | | 1979: 6,314,000 metric tons |
| | Crude Steel Production | 1950: 56,000 metric tons |
| | | 1979: 466,900 metric tons |
| | | (19.2% increase over 1978) |

In Chile, Campania de Acero del Pacifico (CAP) is a producer of iron ore and pellets. Full capacity was reached in 1980 only with 5.7 and 3.1 million metric tons produced respectively. A further $60 million will be invested to improve efficiency of operations at the El Romeral ($15-20 million) and at the Los Colorados ($7-10 million) mines. The remainder of the investments is earmarked for technological improvements and partial conversion from oil to coal operations at various places.[29] Note also that Chile exported 4.117 and 2.865 million metric tons of iron ore and products respectively.

Europe

| | | |
|---|---|---|
| Spain | Iron Ore Production | 1950: 1,044,000 metric tons |
| | | 1979: 4,242,000 metric tons |
| | Crude Steel Production | 1950: 815,000 metric tons |
| | | 1979:12,120,000 metric tons |

Spain is another among the countries suffering from a depressed steel industry due to a reduction since 1974. Since that year steel consumption decreased from 12 to 8 million metric tons or by 33 percent. Still, steel output production is rising again as Spain has raised its exports from one to 5.5 million metric tons during this particular period of time. During those years the amounts of annually produced iron ore had been at about 4 million metric tons (metal content) which still was insufficient to support the

domestic iron and steel industry of Spain. 5 million metric tons of mostly high-grade iron ores were imported each year while the traditional export market for Spain iron ore in Europe shrank to a mere 900,000 metric tons by the year 1979.[30]

Three projects are underway to raise output to a total of 12.6 million metric tons of ore or to 6 million metric tons of iron. The first of these to be mentioned is that of Sierra Minera. It expects its output to rise to 3.5 million metric tons (2.3 million metric tons in metal content) through the construction of a pellet plant to be fed by domestic and imported ores.[31] The second of these projects provides for an investment of $242 million to produce eventually 1.6 million metric tons of concentrates. It also deals with the production of prereduced pellets for the non-integrated steel companies in substitution of imported scrap.

The third is a waste utilization project. Here, one million metric tons of iron pellets (6.25% iron) will be extracted from pyrite ash annually. Although the intentions were well-directed with the special objective in mind to reduce import-dependence in raw materials for the Spanish iron and steel industry a general lack in demand by an ailing iron and steel industry does not facilitate the financing of these programs. The same source argues that success could be assured were the government of Spain to decide to support or to participate in these plans for whatever reason.

| | | | |
|---|---|---|---|
| U.S.S.R. | Iron Ore Production | 1950: | 23,345,000 metric tons |
| | | 1979: | 149,742,000 metric tons |
| | Crude Steel Production | 1950: | 27,300,000 metric tons |
| | | 1979: | 149,004,000 metric tons |

By the year 1979, the U.S.S.R. had 135 iron ore mines in operation with a production capacity of 297 million metric tons of usuable iron ore. Its concentrator facilities counted 92 including 29 with sinter and some with pelletizing capabilities.[32] Actual production was still below capacities but output levels will, no doubt, be raised. So will the planned capacities within the framework of the 1981-85 five-year plan.

However, there is one international joint venture which has attracted general attention. In the year 1973 an agreement was reached between the U.S.S.R. and Finland to build the Kostamus iron ore complex in Soviet Karelia about 20 miles east of the Finnish border. The three stage project was expected to cost $700 million[33] with construction to last from 1977 to 1982. Finally, annual production capacity will be 8.9 million metric tons of pellets produced from 24 million metric tons of crude ore. The reported ore reserve is 1.2 - 1.5 billion metric tons prompting a life expectancy of this ore deposit of between 50 and 62 years. Finland has agreed to buy back annually up to 1.2 million metric tons of pellets which is equivalent to 13.5 percent of the expected annual output between the years 1983 and 1990.[34]

In short, the U.S.S.R. is the largest holder of iron ore reserves in the world and there is no doubt that these resources will be utilized to the fullest in the years to come. Recently, however, overall iron ore production in the U.S.S.R. was falling behind targets such that traditional exports to consuming countries in Western Europe and to Japan were curtailed. This situation is expected to continue for an unknown period of time, at least in the early years of the 1980s.[35] It will be interesting to watch the degree of Brazil's success in future sales of its high-grade ores to the U.S.S.R. and, in turn, the internal production developments and exports of ore products from the U.S.S.R.

The truth is that the U.S.S.R. is a net exporter of iron and steel products including iron ore. About 20 percent of all iron ore mined in that country is exported, although a slowdown in these exports was noticeable at the end of the 1970s.

The complexity of the problem and the difficult and time-consuming task of 'ferretting out' substantial and permanent information on this country prevents any further and detailed discussion of this most interesting problem.

Empirically, annual increases in iron ore production (metal content) averaged 3.71 million metric tons over the last eight years excluding the great rise from 1977 to 1978. If the increase for 1978 is included the average

annual expansion would run at 4.85 million metric tons. It would be reasonable to assume that the U.S.S.R. will add roughly 4.0 million metric tons annually to its iron ore capacity in the future.

| | | | |
|---|---|---|---|
| Yugoslavia | Iron Ore Production | 1950: | 354,000 metric tons |
| | | 1979: | 1,638,000 metric tons |
| | Crude Steel Production | 1950: | 428,000 metric tons |
| | | 1979: | 2,316,000 metric tons |

Yugoslavia's steel industry has been import-dependent to about 46 percent as 3 million metric tons of ore had to be purchased from outside the country. These imports added a severe burden on the balance of Yugoslavia's international payments. Existing iron ore mines will be pressed to raise outputs. For instance, the Ljubija mine of the Zenica complex in the Bosnia-Hercegovina is a case in point. In addition, a new mine was reported under construction which will produce 2 million metric tons initially when it starts operations in 1983. Eventually, output will climb to 6 million metric tons annually. It is located at Omarska and will be phased into the Ljubija system of the Zenica complex.

Africa

| | | | |
|---|---|---|---|
| Liberia | Iron Ore Production | 1951: | 118,000 metric tons |
| | | 1952: | 606,000 metric tons |
| | | 1979: | 13,513,000 metric tons. |

From a position of an insignificant producer of iron ore, Liberia moved up very quickly within the ranks of the ten largest iron ore producers in the world. Liberia has had difficult times due to problems in the Western Sahara which the late President Dr. William R. Tolbert, the Chairman of the OAU, wanted to solve before his assassination when his government succumbed to the revolt in this country. Furthermore, the Liberian governments have continuously faced severe financial and economic problems, then and now. Eventually they were to be dealt with by the National Development Programs.[36] The second of these is thought to concentrate on solving the food problems through the promotion of agriculture and forestry with a lower emphasis on the exports of staples such as iron and rubber.[37]

Liberia's iron ores come mainly from three units:

Lamcon Joint Ventures (LJV),

Bong Mining Company (BMC), and

the National Iron Ore Company (NIOC).

The first of these, Lamcon Joint Ventures, mines its own ores but also handles ore of the Mifergui-Nimba Company. This ore comes from the Mount Nimba deposits in Guinea. The high grade of the ores permits the production and shipping of iron ore products of very high quality (Table 5).

The next phase in the development of Liberia's iron ore industry could be directed towards the opening-up of the

Wologisis deposits. They are in the hands of the Liberia Iron and Steel Corporation (LISCO) with an extended option in the hands of a Japanese group of steel firms for the purchase of a majority share of LISCO. The Japanese firms are Kawasaki Steel, C. Itoh and Company, Missho Iwai and Company, the Marubeni Corporation and Toya Menka Kasha. They and LISCO are contemplating an investment of between $300 and $400 million to produce another four to seven million metric tons of iron ore. This project with a targeted start of operations in 1983 would raise Liberia's annual iron ore output by between 30 and 50 percent. In particular, the annual output of seven million metric tons of sinter feed are a reported objective[38] which includes the construction of a 145 mile slurry pipeline to the Port of Monrovia with the government providing the infra-structure such as town sites, electricity supply and roads.

Guinea — Iron Ore Production 1953-1959: (199,000-547,000(1957) metric tons

1960: 800,000 metric tons

1970:1,040,000 metric tons

This country has a major iron ore project in progress. It would mean a conspicuous return of Guinea to the iron ore scene of the world.

An open-pit mine is planned which is expected to produce 8 million metric tons of ore annually. This ore is to be transported to Liberia on a 12 mile rail link. Total cost of

this investment is estimated at $600 million.[39] However, the implementation of the investment plan has suffered a delay due to the change of government in Liberia.

Senegal

The plan for a new iron ore mine in the far east of Senegal is being drawn up. It involves the utilization of the Falémé River iron ore deposits amounting to 610 million metric tons of which 410 million metric tons consists of a magnetite ore with a grade of between 45 and 50 percent iron. Another 100 million metric tons are oxides with an ore grade of between 62 and 65 percent iron. A new company consisting of the Government[40] and three foreign firms will invest $1 billion to produce 7.5 million metric tons of pellets, starting in about 1987. The success of the project depends to a large degree on transportation and the supply of electrical power. In regards to the problem of electricity, Senegal is tied in closely with its neighbour and future iron producer Mali. The two countries are planning to build the Manatali power dam on the Senegal River.

Mali

Mali is another country which is not yet on the list of iron producers of the world. Two orebodies have been discovered: one is at Bafing-Yakana and it has, according

to an estimate by U.S.S.R. experts and geologists of the National Geological and Mining Service, an ore reserve of 150 million metric tons with an ore grade ranging from between 36 and 67 percent iron. The other is an extension of the Falémé River deposit. This occurrence is under study by BRGM.

Algeria Iron Ore Production 1950: 1,361,000 metric tons
1979: 1,639,000 metric tons

Algeria is a country of many mineral deposits which have not been exploited due to their remoteness from the industrial perimeters in the north, a cruel climate and unsatisfactory market conditions.

So far, Algeria produces 4 million metric tons of iron ore annually with an approximate grade of 40 percent iron content.[41] In order to promote its iron industry, the Algerian government has approached foreign companies to rouse their interest going as far as to offer partnerships in such ventures. Unfortunately, few details are known surrounding these projects. For instance one steel complex is under construction at La Macta in which U.S., Canadian, and Japanese firms are reportedly involved. Another two steel plant construction projects are in progress. One at Annaba - the El Hadjar works, and the other at Jijel. This one is known to have experienced some delay in its completion.

The feed for these steel plants comes mainly from the SONAREM mines which are owned by the Algerian government. Their output, however, is not sufficient to supply the Algerian iron and steel industry and will have to be supplemented with ores from other sources. The most important of these supplementary sources will come from the huge capital investment in the Gar-al Jabilet (Gara-Djebilet) project.[42] The Societé Nationale de Sider plans to have it in operation by 1986. The ore reserves is estimated at 3 billion metric tons with Bechtel and Nippon Steel providing necessary technical assistance. This investment project also calls for the construction of a 620-mile railroad.[43]

| | | | |
|---|---|---|---|
| Mauritania | Iron Ore Production | 1962: | 656,000 metric tons |
| | | 1963: | 841,000 metric tons |
| | | 1964: | 3,234,000 metric tons |
| | | 1978: | 4,734,000 metric tons |
| | | 1979: | 6,480,000 metric tons |

Mauritania was a late starter in producing iron ore. It was not before 1962 that it entered the world iron scene and two years later that iron ore output jumped into 'full gear'. By the year 1979, Mauritania had approximately increased its output tenfold over its small beginnings. It is the Société Nationale Industrielle et Minière (SNIM) which owns the Complex Minier Du Noro which, in turn, operates the

main three mines.[44] These three mines deliver a 68% high-grade iron ore via a 388-mile railroad line to the port of Nouadhibou. Unfortunately, they face depletion by the end of the 1980s. For this reason two outlying deposits will be opened up. The project envisages the exploitation of two rocky outcrops or hills - something similar to the familiar buttes in the west of North America - at El Rhein and Oum Arwagen. They are located 25 miles to the north of the present mines.

The El Rhein stage requires an investment of $500.7 million to have it in operation by 1982-3. The mine and the beneficiation plants will deliver 3.11 million metric tons of a 65 percent grade iron ore product from an ore grading 37 percent iron.[45] The Oum Arwagen stage will come under construction in 1986 to start operating three years later when the first three mines come to a close. An extension of the existing railroad by 7.5 miles is also called for in this connection. The combined strength of production will amount to 14 million metric tons of concentrates per year drawing on an ore reserve of 1 billion metric tons. Given this rate of exploitation the life expectancy of this double mine would be between 30 and 35 years.

Finally, there is the third project for the Mauritanian iron ore industry. A pellet plant is being constructed with a capacity to produce 2 million metric tons of such iron ore

products. It will be located at the port of Nouadhibou and will cost an estimated $231 million. It should be in operation by 1982-3. It is owned by the Société Arabe des Metallurgique (SAMIF) representing a joint venture between Mauritania and the two Japanese firms of Kobe Steel and Tokyo Boeki.[46]

Gabon

Thanks to its mineral wealth Gabon will become another new entrant on the scene of world iron ore production. When the Trans-Gabon railway will be completed SOMIFER will be able to run an open-pit mine at Belinga in Mekambo. The plan calls for the production of 15 million metric tons of ore per year relying on a 2 billion metric ton ore reserve with a grade of 62 percent iron. Gabon, therefore, serves as another example of the future potential competition in the world iron ore market which can be expected to come from Africa.

Nigeria

The Nigerian Steel Development Authority is in the process of building a steel plant with an annual capacity to produce 1.3 million metric tons of steel which later may be raised even to between 2.6 and 5.2 million metric tons. The Ajaokuta Project[47]. The ore source from which this plant

is to be supplied is the Itakpe mine in Kwara which will produce 4 million metric tons of concentrates per annum.

| | | | |
|---|---|---|---|
| Angola | Iron Ore Production | 1956: | 9,000 metric tons |
| | | 1971: | 3,819,000 metric tons |
| | | 1975: | 1,664,000 metric tons |

Angola has about 92 million metric tons of taconite ore with a grade of 32.5 percent iron. This deposit is located at Cassala-Quintungo. An Austrian engineering firm has plans for a beneficiation plant to produce 2 million metric tons of super-pellets annually. In addition, resumption of operations of the low-grade ores of the Corringa region are also contemplated. Production in the region had come to a halt with the depletion of the marginal orebody and the interruption of the Mocamades railroad which carried ore through UNITA territory.[48]

Asia

Bahrain

One country with no proven iron ore-reserves is Bahrain which has to rely on imports to supply needs for any form of an iron and steel industry. The Arab Iron and Steel Company will invest $300 million to build a pellet plant with a capacity to produce 4 million metric tons of iron ore pellets. The ores will be imported from other countries such as India and Brazil. This plant should be on stream in 1983.

| | | |
|---|---|---|
| China | Iron Ore Production | 1950: 30,250,000 metric tons |
| | | 1977: 32,500,000 metric tons |
| | | 1979: 33,000,000 metric tons |
| | Crude Steel Production | 1950: 2,225,000 metric tons |
| | | 1960: 18,450,000 metric tons |
| | | 1979: 34,430,000 metric tons |

China is at the crossroad leading towards rapid industrilization. The task ahead is immense and China is determined to meet the iron and steel demands facing its expanding economy. By 1985 its crude steel output is to be between 45 and 50 million metric tons. This will be accomplished by modernizing medium-sized steel operations, by expanding existing steel works and by building new mammoth steel complexes.

To supply the steel industry, China disposes of 40 billion metric tons of mostly low-grade, Mesabi-type iron ores. They will be utilized to feed the steel industry as much as possible. China intends to make the existing Anshan works into the largest steel complex in the world by raising their capacity from 6.9 million metric tons to 15 million. Sumitomo of Japan has proposed to build a new plant adjacent to the existing plant. Its capacity would be 6 million metric tons while Anshan itself will be expanded. It is the U.S. Steel Corporation which has a contract to build a mining plant with a capacity to produce 17 million metric tons of pellets

annually. It will be located at Chi-Ta-Shan, Liaoning Province as one of the mines feeding the Anshan complex.

Another steel project involves a proposal by a German consortium to erect a steel plant at Jidon at a cost of $14 billion. However, the most impressive complex under construction, is that at the Yangtze and Whompoa Rivers spreading over 4.25 square miles. It will cost $5.6 billion and is designed to deliver 6 million metric tons of steel by 1985; its output is to be raised later to 10 million metric tons.

The ore production, too, will be raised significantly, but there is no doubt, that China will not be an alternative supplier of iron ores in the world market. On the contrary, China can run its steel and iron works to capacity only by supplementing its own iron mine output with imports from abroad. In short, China will be a net importer of iron ores for years to come, unless some additional huge and high-grade iron ore deposits are discovered in mainland China.

| | | | |
|---|---|---|---|
| India | a) Iron Ore Production | 1950: | 1,929,000 metric tons |
| | | 1977: | 2,652,000 metric tons |
| | | 1979: | 24,600,000 metric tons |
| | b) Crude Steel Production | 1950: | 1,461,000 metric tons |
| | | 1977: | 9,836,000 metric tons |
| | | 1979: | 9,960,000 metric tons |

Ratio a/b: 1950 = 1.32

1979 = 2.46

As pointed out in Table 11, the geographically large country of India is also one of the most important holder of iron ore reserves. According to that Table, India is the sixth largest iron ore reserve country accounting for at least 7.89 billion metric tons of iron content. These reserve estimates appear conservative in light of more optimistic projections which would allocate to India at least between 8.67 and 15.3 billion metric tons of iron in ore form.[50]

When one considers the annual iron ore production of India in comparison with its crude steel output, it is apparent that India is a net exporter of iron ore. As a matter of fact, about 50 percent of all recently mined iron ore has been sold outisde the country, a fact which helps to generate considerable foreign exchange for India. For instance, in 1976-77 21,8 million metric tons out of a total of 42.3 million metric tons of ore were exported. They went mainly to the following countries:

| | |
|---|---|
| Japan | 75.7 percent |
| Romania | 6.7 percent |
| the Netherlands | 3.2 percent |
| the Republic of Korea | 3.0 percent |
| | 88.6 percent |

India's steel industry consumed about 17 million metric tons in 1977. By 1983 the expansion of the steel industry will require an ore feed of 25 million metric tons or an increase

of iron ore inputs by 8 million metric tons. Over the same period of time the State plan of India provides for a 51 percent rise in ore production from 42 million metric tons (1977-78) to 65 million metric tons. This means an increase in output by 23 million metric tons. In turn, this implies that an additional 15 million metric tons of ore should be available for exports should the plan be fulfilled.

The iron and steel industry of India suffered from various ills.[51] Shortages have been reported for such items as cold-rolled sheets and coils, wire rods and hot-rolled coils and strips, electrode-type wire rods and cables. With the consumption demand for steel exceeding actual production by 20 percent, India is trying seriously to satisfy its need for steel from domestic sources as best it can. It has gone as far as banning the export of pig iron though not the the exports of ores. The Indian iron and steel industry is also affected by shortages of power, coal, and transportation services.

Should these problems continue while the iron ore production runs on schedule, the amount of iron available for export would tend to be larger than the estimated 15 million tons of additional ores. The grades of these exported iron ores will also be better than the ores absorbed by the domestic iron inudstry of India. This is so because the greatest new iron ore mining projects of the government of India is

the Kudremukh open-pit mining installation. The estimated reserve is 610 million metric tons of ore which has a relatively high grade of containing 66 percent iron. $806 million are reported as the size of this investment to increase the annual output from 3.0 million to 7.5 million metric tons already by 1980.[52] Furthermore, a plant at Mangalore is to produce 3 million metric tons of pellets at a cost of $150 million, bringing the investment total to $956 million.[53] It is of great importance to realize that this iron ore is of a similar quality as the Brazilian Carajas ore even if the size of the Indian deposits is but a fraction of Brazil's. Nonetheless, it is the high grade of this ore which will supply the needs of neighbouring Iran,[54] just as it will assure India its prominent place among the iron ore producers and exporters of the world for a considerable period of time in the future.

Australasia

| | | | |
|---|---|---|---|
| Australia | Iron Ore Production | 1950: | 1,440,000 metric tons |
| | | 1979: | 53,875,000 metric tons |
| | Crude Steel Production | 1950: | 1,263,000 metric tons |
| | | 1979: | 8,136,000 metric tons |

Australia's significance as a world iron ore producer is presented through these introductory statistics. Between

1950 and 1979 its output of iron ores rose by a factor of 37.4, whereas the crude steel production, already smaller than the output of iron ore in 1950, expanded merely by a factor of 6.4. In other words, when the iron ore production exceeded that of steel by 14 percent in 1950, thirty years later the difference was 562.2 percent. Consequently, Australia has become-and that had been brought out in Table 4- one of the chief sources of iron ore in the world. Approximately, two thirds of all iron ore exported by Australia goes to Japan, with the remainder destined for the European Economic Community, the Peoples' Republic of Korea, Taiwan and mainland China.

Australia's iron ore reserves are the fourth largest in the world (Table 11), exceeding even those of the United States. The chief supplier of these ores in the Pilbara Region in north-western Australia. It accounts for about 90 percent of annual ore production. The remainder comes chiefly from the Dampier ore mine of Koolyanobbing, east of Perth, the Middleback Range in South Australia (Broken Hill Proprietory Company) and from the Savage River in Tasmania where the ore is pumped through a slurry pipeline to Port Latta for pelletizing and subsequent shipment to Japan.[55]

It is the Dompier Mining Corporation which has plans for an open-pit mine and, possibly, a plant at Deepdale located at the western tip of the famous Hamersley Range in

Western Australia. Once water supply, power sources and a townsite have been secured, the investment ready to be allocated to this operation would amount to $350 million. The aim is to produce 1 million metric tons of ore annually at some time in the 1980s.[56]

Another, and even more important project involves the CSR Ltd., formerly a sugar company. Recently, a 3 billion metric high-grade iron ore deposit was discovered at Yandicoogina in the same Pilbara Region. In order to open up this huge deposit CSR is bidding for Japanese approval to develop this deposit jointly by offering 35 percent equity participation to the Japanese steel mills. Other offers to foreign steel producers as, for instance, to firms in Korea and Taiwan would raise foreign equity participation to the legally possible limit of 49 percent.[57] This project could require $1 billion to produce 10 million metric tons of ore annually by the year 1985; eventually, annual output could climb as high as to 20 million metric tons by 1989.[58] In light of these two projects alone, Australia's annual iron ore production would rise by 21 percent by the year 1989.[59] Yet, this is not all.

Another two projects to extract iron ore should be mentioned, both involving the Role River iron ore consortium (RRIOC): in one, this consortium is close to start the exploitation of a 150 million metric ton iron ore reserve in the east of

the Deepdale area. However, this project would merely replace the depleted ore supply of the Mesa operations; as to the other, discussions have taken place in 1980 with Japanese firms about the development of the 700 million metric ton fine-grained iron ore deposit at West Angela.[60]

Both, the CSR and the RRIOC proposals highlight the fact that the Japanese have more than one alternative ore resource in Australia to choose from. Just as the Japanese steel makers consider CSR's Yandicoogina project, they have altogether five such proposals at hand, each offering equity participation. In addition, one cannot deny a feeling that, after all, Australia's ore reserves seem to be substantially larger than initially indicated in Table 11.

These investment projects underscore the huge potential in the iron ore field alone. Were one to extend the analysis only slightly to include the investments in concentrators and beneficiation plants the resulting picture would likewise illustrate other sources of increases in the output of iron ore products. Recently, (1979) the commissioning of such installations involved a total capital commitment of about $418 million.[61] In short, there should not be any doubt about the immense vitality of the Australian iron ore industry whose future is more than assured not only by huge high-grade deposits but also by very ready customers at its doors.

The Philippines

| | | |
|---|---|---|
| Iron Ore Production | 1948: | 10,000 metric tons |
| | 1950: | 322,000 metric tons |
| | 1973: | 1,414,000 metric tons |
| | 1976: | 345,000 metric tons |

The iron and steel industry of the Philippines is in its infancy. Between 1950 and 1979, neither steel nor pig-iron production figures were recorded in the statistics of the United Nations. However figures for the production of iron ore were listed starting with a low of 10,000 metric tons of iron content in 1948. It reached a peak in 1973 as 1,414,000 metric tons of iron were mined. By 1976, output had diminished to 354,000 metric tons.

Indications are that the Philippines will move towards an expansion of its iron ore industry. The Santa Ines Mining Company plans to open up a magnetic iron ore mine in Rizal. It is expected to produce 1.5 million metric tons of iron ore concentrates annually at an investment cost of $38 million.[62] The success of this project would assure that the iron ore output of the Philippines would finally exceed that of the year 1973. It is also reported that the Santa Ines Mining and Steel Corporation would obtain the necessary equipment for the beneficiation plant through supply credits of $21 million from Lurgi, a subsidiary of the German Metallgesellschaft. In turn, Lurgi will receive $2 million in equity or 20 percent of the total. This plant should be on stream by the spring of 1983.[63]

## SECTION V: IRON ORE: THE FUTURE OF PRICES, SUPPLY AND CONSUMPTION

At first, this section discusses briefly past behaviour of the annual prices of iron ore, pig iron and carbon steel plates. This discussion is followed by a forecast of iron-ore prices as provided by the econometric analysis; subsequently a presentation is made of the future of world iron ore production until the year 2004. Finally, an attempt is made to bring the consumption of the metal iron into focus in relation to iron ore production. This is done via the forecast of crude steel production.

### Historical Prices: Iron Ore, Pig Iron and Carbon Steel Plates

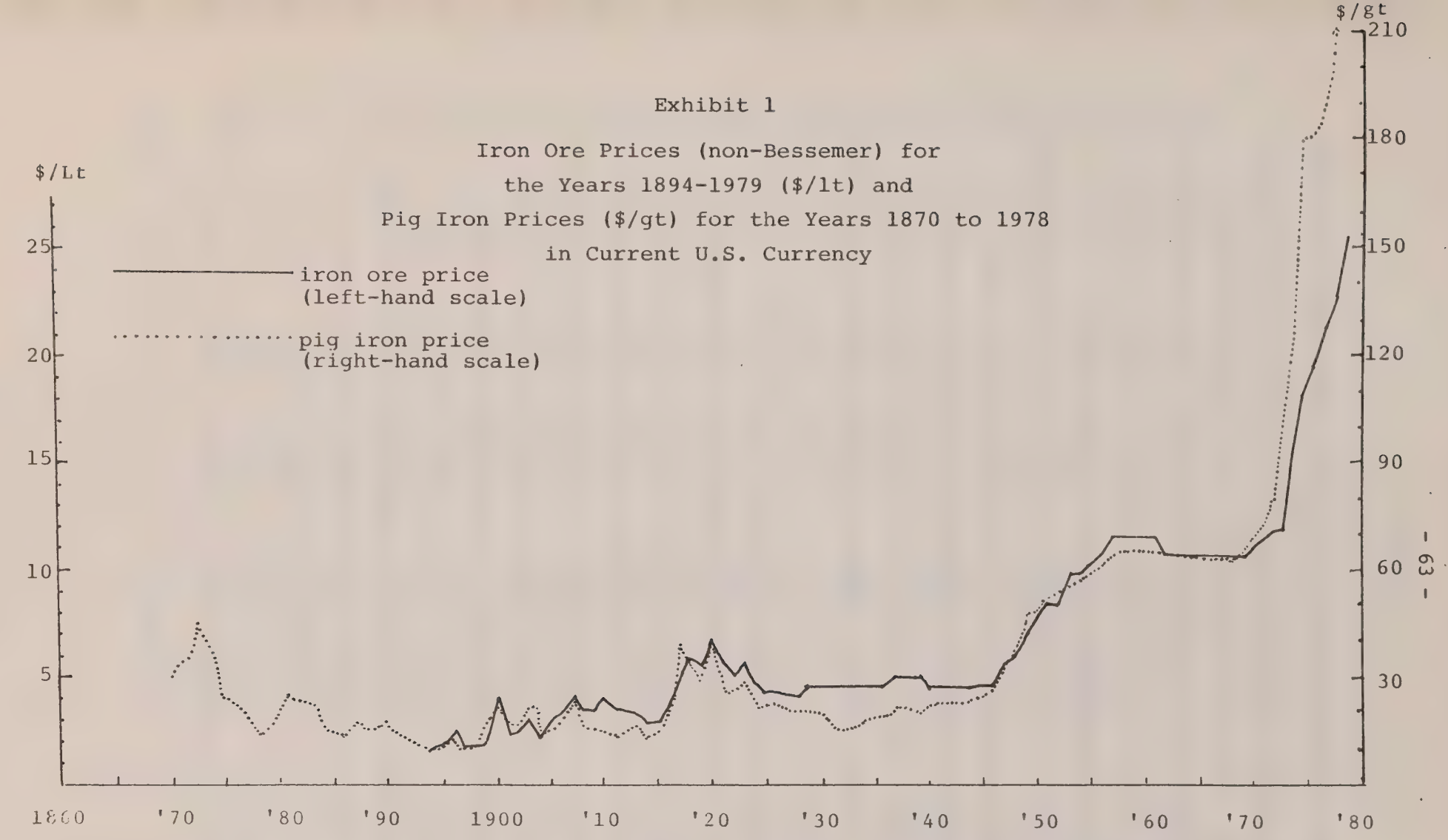
Among the variety of iron ore types, the Non-Bessemer type of ore product has been selected to demonstrate past and future behaviour of the annual prices of iron ore products in general.[64]

Starting with the year 1894 (Exhibit 1), the price stood at $1.75/lt. By 1900, it reached $4/lt, only to drop back to annual lows of $2.35/lt in 1901 and 1904. By 1907 and 1910 it reached the $4/lt level again. Only in 1917 did the iron ore price exceed the $5/lt mark. In 1920 iron ore cost $6.55/lt. Afterwards, it was lower but stable for 22 years as it stayed within the range of $4.25/lt and $4.95/lt until 1947.

This was the year which heralded the beginning of a rise

Exhibit 1

Iron Ore Prices (non-Bessemer) for the Years 1894-1979 ($/lt) and Pig Iron Prices ($/gt) for the Years 1870 to 1978 in Current U.S. Currency




Source: [a] Iron Ore: U.S. Department of Commerce, Historical Statistics of the United States, Colonial Times to 1970, Past I, Washington 1975, p. 599 (M205-220); (1894-1970) Statistical Abstracts of the United States, 1970-1980 also. Engineering and Mining Journal

[b] Pig Iron: Neal Potter and Francis T. Christy, Jr. Trends in Natural Resource Commodities, Resources for the Future Inc. John Hopkins, Baldimore, 1962, p. 334. MP-12 C (1890-1957), A (adj.) 1970 to 1889)
America Metal Market, Metal Statistics 1979, A Fairchild publication, New York, N.Y. p. 198-201. (est.), 1979.

in iron ore prices which only levelled off from $11.45/lt (1957 to 1961) to between $10.55 and $10.65/lt (-1969). The steepest price incline of iron ore started in 1970. From $11.71/lt in 1973 it rose quickly to $15.30/lt in 1974, to $17.89/lt in 1975, to $19.42/lt in 1976, to $21.18/lt in 1977, to $22.85 in 1978 and an estimated $25.47 for the year 1979.[65]

In retrospect, a relative price stability characterizes the behaviour between 1900 and 1947, although in a more general perspective a rising tendency is clearly noticeable between 1894 and 1972. However, the subsequent and sudden break-out to $25/lt reflects certain unusual economic conditions of the late 1970s.

The price of pig iron is traced back to 1870 in dotted form in the same exhibit. This price displayed an actual decline from $46.90/gt in 1872 to $9.98/gt in 1897. Going back further into history, the reader will be surprised to find that the price of pig iron in the United States in the year 1864 was $59.25/lt which was surpassed only in 1956 when it rose to $60.69/lt (Table 12). Another and earlier high was recorded for this type of iron in 1815 (Table 12) when it ran at $53.75/lt. Also it is noteworthy to point out that the lowest price of pig iron for the entire historical period from 1799 to 1979 was recorded for the year 1898. Then, it was $11.66/lt.

When using five-year average prices, pig iron averaged

Table 12

Pig Iron Prices for the Years 1799 to 1970 in Current $US/lt

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1970 | 69.69 | 1927 | 17.71 | 1884 | 19.87 | 1841 | 28.50 |
| 1969 | 64.09 | 1926 | 18.44 | 1883 | 22.37 | 1840 | 32.75 |
| 1968 | 63.00 | 1925 | 19.59 | 1882 | 25.75 | 1839 | 30.00 |
| 1967 | 63.00 | 1924 | 20.23 | 1881 | 25.12 | 1838 | 32.25 |
| 1966 | 63.00 | 1923 | 25.71 | 1880 | 28.50 | 1837 | 41.25 |
| 1965 | 63.00 | 1922 | 23.98 | 1879 | 21.50 | 1836 | 41.50 |
| 1964 | 63.00 | 1921 | 21.87 | 1878 | 17.62 | 1835 | 30.25 |
| 1963 | 63.00 | 1920 | 42.05 | 1877 | 18.87 | 1834 | 30.25 |
| 1962 | 65.30 | 1919 | 27.49 | 1876 | 22.25 | 1833 | 38.25 |
| 1961 | 66.00 | 1918 | 32.50 | 1875 | 25.50 | 1832 | 35.00 |
| 1960 | 66.00 | 1917 | 39.10 | 1874 | 30.25 | 1831 | 35.00 |
| 1959 | 66.00 | 1916 | 19.87 | 1873 | 42.75 | 1830 | 35.00 |
| 1958 | 66.00 | 1915 | 13.78 | 1872 | 48.87 | 1829 | 35.00 |
| 1957 | 64.83 | 1914 | 12.89 | 1871 | 35.12 | 1828 | 35.00 |
| 1956 | 60.69 | 1913 | 14.77 | 1870 | 33.25 | 1827 | 39.25 |
| 1955 | 57.20 | 1912 | 13.90 | 1869 | 40.62 | 1826 | 46.50 |
| 1954 | 56.00 | 1911 | 13.10 | 1868 | 39.25 | 1825 | 46.75 |
| 1953 | 55.25 | 1910 | 14.73 | 1867 | 44.12 | 1824 | 40.00 |
| 1952 | 53.08 | 1909 | 15.52 | 1866 | 46.87 | 1823 | 35.25 |
| 1951 | 52.00 | 1908 | 15.21 | 1865 | 46.12 | 1822 | 35.00 |
| 1950 | 47.04 | 1907 | 23.89 | 1864 | 59.25 | 1821 | 35.00 |
| 1949 | 46.00 | 1906 | 20.98 | 1863 | 35.25 | 1820 | 35.00 |
| 1948 | 41.60 | 1905 | 17.88 | 1862 | 23.87 | 1819 | 36.50 |
| 1947 | 33.82 | 1904 | 15.57 | 1861 | 20.25 | 1818 | 42.25 |
| 1946 | 27.13 | 1903 | 19.92 | 1860 | 22.75 | 1817 | 47.00 |
| 1945 | 24.52 | 1902 | 22.19 | 1859 | 23.37 | 1816 | 50.25 |
| 1944 | 23.50 | 1901 | 15.87 | 1858 | 22.25 | 1815 | 53.75 |
| 1943 | 23.50 | 1900 | 19.98 | 1857 | 26.37 | 1814 | 46.00 |
| 1942 | 23.50 | 1899 | 19.36 | 1856 | 27.12 | 1813 | 47.25 |
| 1941 | 23.50 | 1898 | 11.66 | 1855 | 27.75 | 1812 | 47.50 |
| 1940 | 22.50 | 1897 | 12.10 | 1854 | 36.87 | 1811 | 44.00 |
| 1939 | 21.10 | 1896 | 12.95 | 1853 | 36.12 | 1810 | 38.00 |
| 1938 | 21.71 | 1895 | 13.10 | 1852 | 22.62 | 1809 | 40.00 |
| 1937 | 22.99 | 1894 | 12.66 | 1851 | 21.37 | 1808 | 40.00 |
| 1936 | 19.10 | 1893 | 14.52 | 1850 | 20.87 | 1807 | 38.75 |
| 1935 | 18.17 | 1892 | 15.72 | 1849 | 22.75 | 1806 | 35.75 |
| 1934 | 17.70 | 1891 | 17.52 | 1848 | 26.50 | 1805 | 30.75 |
| 1933 | 15.44 | 1890 | 18.40 | 1847 | 30.25 | 1804 | 29.75 |
| 1932 | 14.25 | 1889 | 17.75 | 1846 | 27.87 | 1803 | 29.25 |
| 1931 | 15.88 | 1888 | 18.88 | 1845 | 29.25 | 1802 | 30.75 |
| 1930 | 17.99 | 1887 | 20.92 | 1844 | 25.75 | 1801 | 32.75 |
| 1929 | 18.20 | 1886 | 18.71 | 1843 | 26.75 | 1800 | 35.75 |
| 1928 | 16.56 | 1885 | 18.00 | 1842 | 28.00 | 1799 | 36.25 |

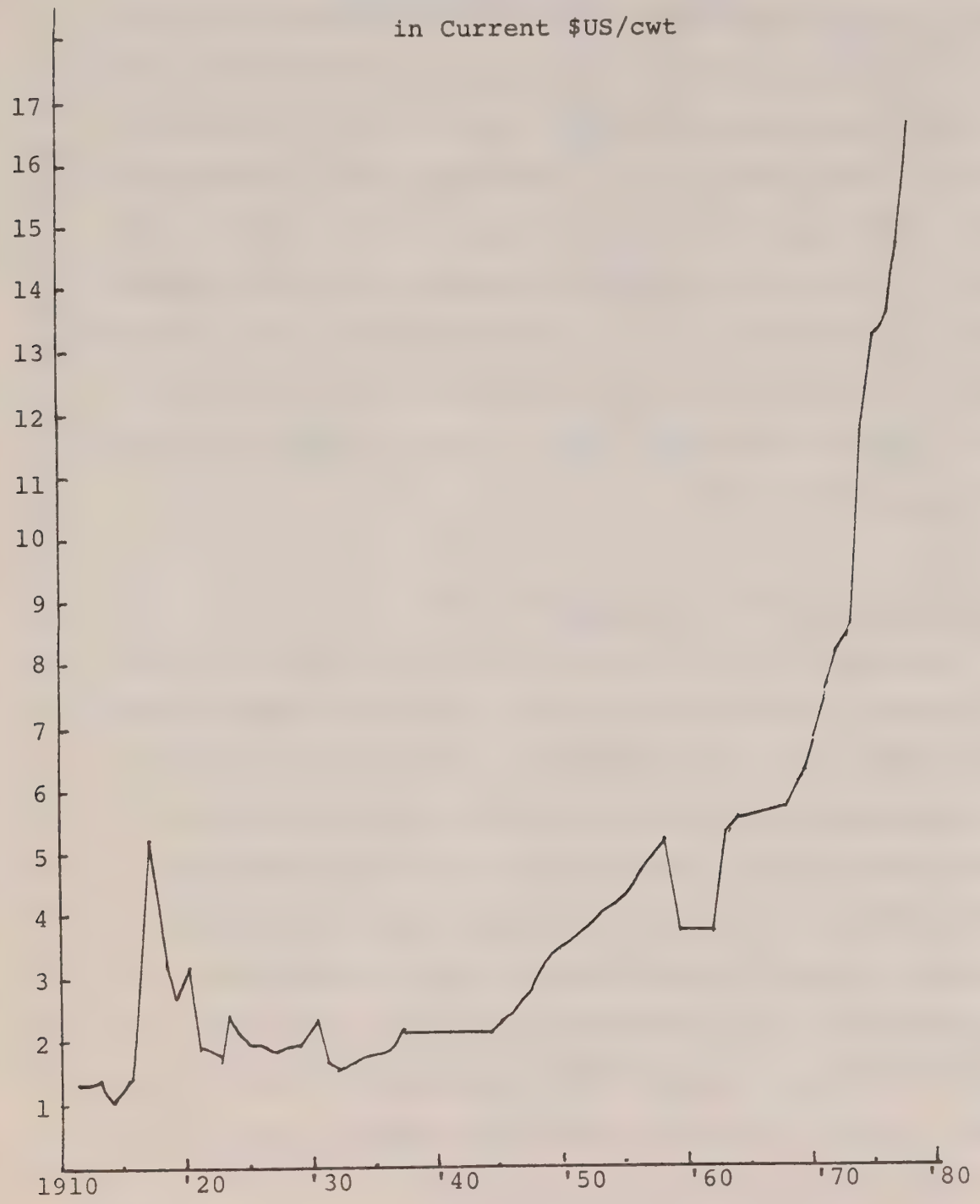
Source: same as Exhibit 1, (a), p. 599-600

$32.95/lt for the period from 1799 to 1803. It was $19.46/lt for the five-year period 1899 to 1903; this means that the price of pig iron had declined by 41 percent over this span of a century. Only after 1947 did the annual price for pig-iron exceed the said five-year average, a price established 145 years earlier. It is therefore clear that the iron industry had experienced a secular decline in the price which pig iron fetched in the market, only to be interrupted by brief peaks in 1815, 1864 and, to a minor degree, in 1880. By 1898, the lowest point had been reached, and, ever since, the general historical trend for the price of this type of iron has been positive.

The prices of carbon steel plates - one of the basic steel products - seem to follow similar trends. In 1911, the price was $1.31/cwt. It declined to $1.14/cwt in 1914, but shot up to $5.21 in 1917, a peak year as may be seen in Exhibit 2. Later on, it settled back with a lack-lustre performance until 1944, as prices remained unchanged at $2.10/cwt from 1939 to 1944. With the year 1945 an upward trend set in. Carbon steel costed $5.18/cwt in 1958. Between 1959 and 1962, the price remained at $3.70/cwt while from 1963 on, a widespread acceleration manifested itself. From $5.36/cwt in 1963 the price of carbon steel plates climbed slowly to $6.26/cwt in 1969. It hit $7.50/cwt in 1971, $8.50/cwt in 1973, $13.41/cwt in 1976, and $16.53/cwt in 1978. A preliminary estimate put the price of 1979 carbon steel plates at $18.00/cwt.

Exhibit 2

Prices of Carbon Steel Plate
For the Years 1911 - 1978
in Current $US/cwt




Source: American Metal Market, Metal Statistics, 1979, A Fairchild publication, New York, N.Y., 1979, p. 203.

In short, a definite consistency is noticeable between the behaviour of the prices or iron ore, pig iron and carbon steel plates. However, it is also to be observed that the iron ore price is much more resilient than, especially, the price of pig iron. Exhibit 1 brings out this important point. Both upward and downward movements are much more pronounced for pig iron than for iron ore. Therefore, the fluctuations are less pronounced for the latter than for the former. In the final analysis of a comparison between the price changes of the three materials, it is clear that between 1911 and 1978 the price of iron ore rose by a factor of 6.4 times, while those of pig iron and carbon steel plates increased 14.16 and 12.61 times respectively.

Future Prices of Iron Ore in Constant $US

Following the econometric analysis the price of iron ore, expressed in constant 1979 $US, will about double between 1980 and 2004. This future behaviour of iron ore prices has been illustrated in Exhibit 3 utilizing the data of Table 13. The iron ore price will rise by about $5.00 from $25.71/lt in 1980 to $30.50/lt in 1989. By 1994, $35.33/lt will be charged for the sale of iron ore and $40.51/lt six years later. By the year 2000, the forecast sees $43.62/lt as a possible figure as, by then, annual price increments will exceed $1.50/lt. In 2004, the price has been computed to stand at $51.03/lt with annual increments running at $2.00/lt.

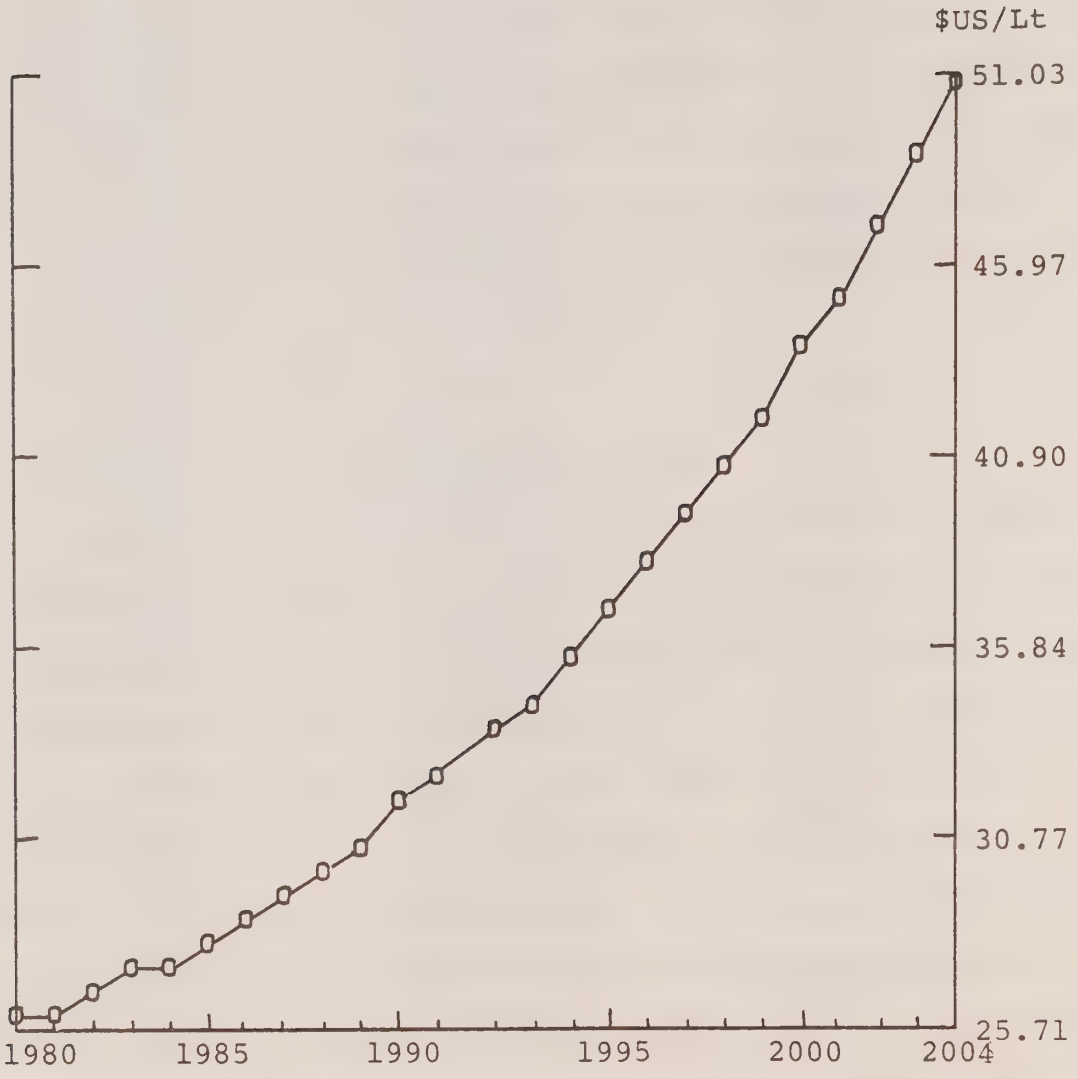
Table 13

Prices of Iron Ore in Constant 1979 $US/lt;
World Production of Iron Ore and of Crude Steel
for the Years 1980 to 2004.

| Year | $ /lt | Iron Ore Output* | Crude Steel Production* |
|---|---|---|---|
| 1980 | 25.71 | 538.733 | 735.789 |
| 1981 | 26.01 | 558.341 | 758.459 |
| 1982 | 26.36 | 578.037 | 781.109 |
| 1983 | 26.78 | 597.818 | 803.737 |
| 1984 | 27.25 | 617.679 | 826.344 |
| 1985 | 27.78 | 637.619 | 848.928 |
| 1986 | 28.37 | 657.635 | 871.491 |
| 1987 | 29.02 | 677.726 | 894.033 |
| 1988 | 29.73 | 697.892 | 916.558 |
| 1989 | 30.50 | 718.133 | 939.066 |
| 1990 | 31.33 | 738.451 | 961.562 |
| 1991 | 32.23 | 758.847 | 984.049 |
| 1992 | 33.19 | 779.323 | 1006.530 |
| 1993 | 34.22 | 7998.82 | 1029.009 |
| 1994 | 35.33 | 820.527 | 1051.491 |
| 1995 | 36.50 | 841.260 | 1073.980 |
| 1996 | 37.76 | 82.085 | 1096.481 |
| 1997 | 39.09 | 883.007 | 1118.998 |
| 1998 | 40.51 | 804.028 | 1141.536 |
| 1999 | 42.02 | 925.153 | 1164.100 |
| 2000 | 43.62 | 946.387 | 1186.695 |
| 2001 | 45.32 | 967.703 | 1209.298 |
| 2002 | 47.12 | 989.107 | 1231.914 |
| 2003 | 49.02 | 1010.602 | 1254.547 |
| 2004 | 51.03 | 1032.194 | 1277.204 |

* Million Metric Tons

Exhibit 3
Iron Ore Prices for the Years 1980 to 2004
in Constant 1979 $US/lt.



This rate of increase appears very reasonable and reflects the general tendency of behaviour. Between 1980 and 2000, the price has been forecast to increase by not quite 70 percent while the projected relative change up to the year 2004 is measured at 98 percent. However, the reader is asked to bear in mind the repeated reservations voiced by the analysts as to the uncertain reliability of a projection extending over such a long period of time.

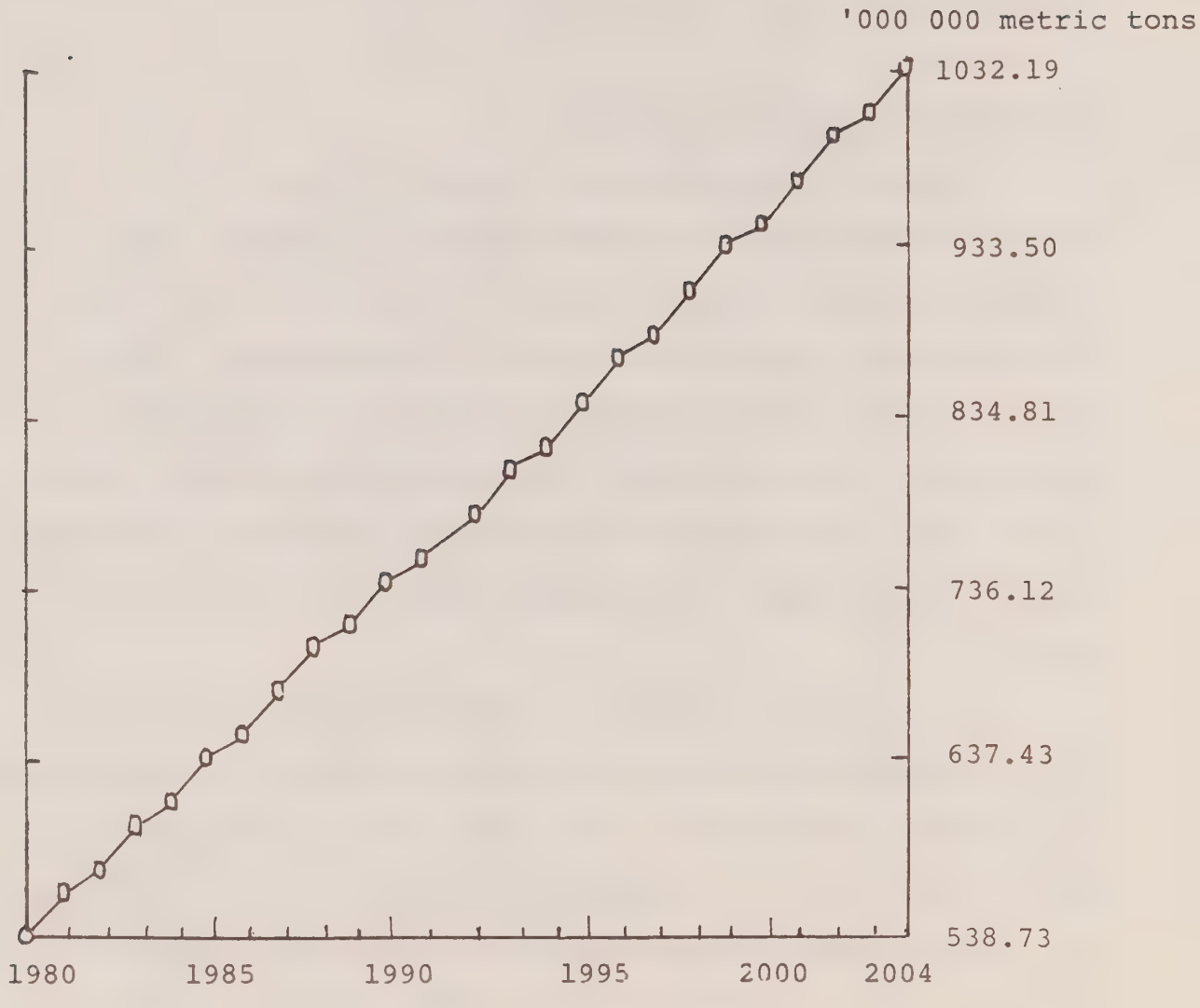
Future World Output of Iron Ore

Based on the econometric forecast, Table 13 and Exhibit 4 demonstrate the world output of iron ore (metal content) over the forecast period. It will rise from 538.7 million metric tons in 1980 to 946.4 million metric tons by the year 2000, representing an increase of 75.7 percent. At the end of the projection, annual world production should reach 1.032 billion metric tons. This amounts to an increase of 91.6 percent over the estimated output level of the year 1980.

This general expansion of iron ore production appears to be continuous and steady as may be judged by the performance illustrated in Exhibit 4. Initially, annual increases have been estimated to be of somewhat below 20 million metric tons of iron ore. Only by 1985 will the annual world output of iron ore rise by about 20 million metric tons. In 1990, 738.4 million metric tons will be produced with an annual increment

Exhibit 4

World Iron Ore Supply
For the Years 1980 to 2004
in Million Metric Tons



running at 20.3 million metric tons over the previous year. It is only in 1997 when the predicted annual world output will reach 883 million metric tons that the annual additions will amount to 21 million metric tons; and for the years 2000 and 2004 annual the world iron ore production will rise by 21.2 and 21.6 million metric tons respectively.

Cumulatively, the following quantities of iron ore will have been extracted:

| By the Year | Million Metric Tons |
|---|---|
| 1985 | 3,528.227 |
| 1990 | 7,018.064 |
| 1995 | 11,017.903 |
| 2000 | 15,538.563 |
| 2004 | 19,538.569 |

By the year 1985 3.5 billion metric tons of iron ore (metal content) will have been mined in the world. Five years later, the cumulatively extracted iron ore will have doubled to 7.0 million metric tons. In 1995 11 billion will have been taken from the ground and with the first year of the next century 15.5 billion metric tons will have been removed from the earth. Over the entire forecast period 19.5 billion metric tons of iron in ore form, thus, will have been passed into and through the hands of men.

Future Production of Crude Steel

The future production of crude steel reflects the consumption of iron ore. It has been set out in Table 13 and

Exhitib 5

World Crude Steel Production
For the Years 1980 to 2004
in Million Metric Tons.

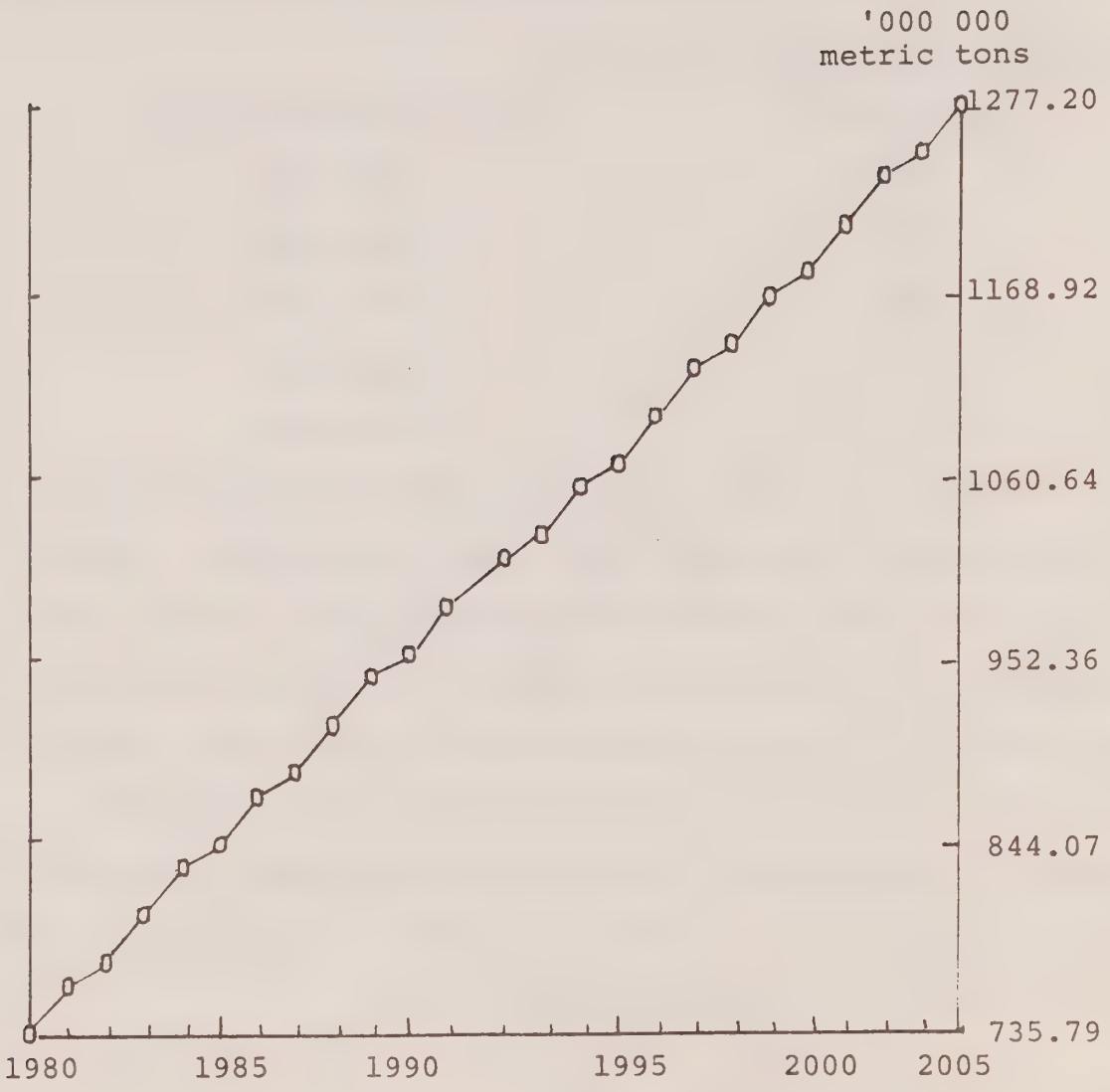


Exhibit 5; but, as in all other of these econometric projections, these values should be taken with the understanding that, as stated repeatedly, the function of the consumption of minerals as used in the simulation analysis serves chiefly and foremostly the purpose of closing the system of mathematical equations. Consumption is not equivalent with demand for the basic mineral. At best, it can express a technical relationship between the demand for the ore which is equal to its production or supply and its consumption of all primary and secondary (scrap) iron forms.

Total crude steel production is estimated to have been 735.8 million metric tons in the year 1980. 73.2 percent of this consumption would have come from iron ore. By 1985, annual crude steel output would run at 848.9 million metric tons with 75.1 percent stemming from primary iron ore production. Five years later 961.6 million metric tons of crude steel will leave the foundries of the world with 76.8 percent originating from iron ore mines. Crude steel output in 1995 will reach 1.07 billion metric tons with 78.3 as the estimated input of newly mined iron ore. The year 2000 will see the world crude steel production running at 1.19 billion metric tons annually. This would imply a 79.7 percent absorption of new iron.

Over the forecast period, annual world crude steel production will have risen by 73.6 to 1.28 billion metric tons

annually, while the content of newly mined iron would account for 80.8 percent of inputs then. Over time the degree of utilization of iron ore in crude steel production would therefore, increase from 73.2 percent in 1980 to 80.8 percent in 2004; and this would apparently occur in spite of the usually large inventories of steel and iron scrap especially in the United States. However, it should be born in mind that this increased reliance on ore rather than on scrap in the years ahead is a by-product of the estimation process and should be considered as probable even if the validity for such an argument has not been established explicitly.

When comparing the results of this forecast with that of other authorities in the field the following observations may be made:

| Year | Dr. E.T. Willauer | Dr. W. Malenbaum[66] | | U.S.B.M.[67] | |
|---|---|---|---|---|---|
| | | World Iron Ore Production (Million Metric Tons and Percentage Differences) | | | |
| 1985 | 637.619 | 615.0 | (-2.39%) | 680.4 | (+12.61%) |
| 2000 | 946.387 | 919.0 | (-2.98%) | 1025.1 | (+ 8.32%) |
| Range 2000 | | | | Max. 1224.7<br>Min. 916.2 | |
| | | World Steel Production[68] | | | |
| 1985 | 848.9 | 896.0 | (+5.55%) | 852.8 | (+ 0.46%) |
| 2000 | 1186.7 | 1301.0 | (+9.63%) | 1279.2 | (+ 7.79%) |
| Range 2000 | | | | Max. 1587.6<br>Min. 1161.2 | |

The comparison reestablishes what has become, by now, a familiar closeness in estimates between Dr. Malenbaum's predictions and those of Dr. E.T. Willauer. For the year 1985 the former's prediction is (-) 2.39% below the forecast value of this study (Willauer); for the year 2000 the difference is (-)2.98%. Compared to the earlier estimates by the U.S.B.M. the difference for the year 1985 shows an excess of +12.61 percent over that of this study and +8.32 percent for the year 2000. Simultaneously, it reveals that Dr. Malenbaum's prediction for the year 2000 is only 0.29 of one percent above the minimum of probable world iron ore output as was assumed by the U.S.B.M. Also, the prediction of this study obviously is closer to the lower than to the upper limit given by the U.S.B.M. In retrospect the forecast by the U.S.B.M. of 1975 appears to be upward biassed. When the projection of the world production of crude steel is included into this comparison, the difference between Dr. Willauer's forecast values and those produced by the U.S.B.M. is almost insignificant as far as the year 1985 is concerned. It is 0.46 of one percent. However, the forecasts for the year 2000 diverge significantly by about 7.8 percent. This somewhat drastic change may imply that the projection of world crude steel production presented by this study tends to understate the values especially for years later down the road towards the next century. This is a possibility which,in turn, may explain the relatively strong decrease in reliance on iron and steel scrap as input sources for the steel industry.

Yet, even the decreasing importance of scrap as an input in that industry appears to be imbedded in the two studies of the U.S.B.M. though to a much smaller degree than this analysis provided.

## SUMMARY AND CONCLUSIONS

Due to its great serviceability the silver-white element of iron has become the most important metal and mainstay of our modern industrialized civilization as this substance is being utilized in peace and war. It is abundantly found on all continents and, to some degree,it has to contend only with aluminum and plastics as substitutes.

The production of crude steel is an expression of the consumption of iron ore. Between 1950 and 1979 world crude steel production tripled while the rate of Canadian steel output rose at least 10 percent faster than that of the world as a whole. In 1950, the United States had been the world's largest steel producer, followed by the U.S.S.R., the U.K., Western Germany, France, Belgium, Japan, Canada, Czechoslovakia and Poland. 30 years later, the U.S.S.R. had become the largest steel producer in front of the U.S.A., Japan, Western Gernamy, China, Italy, France, the U.K., Poland and Canada. The demand for iron ore had been very positively influenced. As a matter of fact, all developing and industrializing countries will follow the examples set by countries such as Mexico, Brazil, Spain and Romania and rapidly expand their iron and steel industries. In turn, these developments will not fail to impose increasing pressures on the demand for iron ores.

Between 1950 and 1979 annual production of iron ore rose by a factor of 3.5; some cyclicality was noticeable. During the same period of time, Canada's iron ore production rose almost 12 fold. This expansion can be explained by the fact that earlier in the same period, the U.S.A., then the world's largest iron and steel producer, was running short of high-grade ores and secured supplies of quality ores by investment in other countries including, of course, Canada. Ontario, however, did not perform as well as did Newfoundland and Quebec; in short, Ontario remained at the margin of world significance as an iron ore producer.

In the 1950s, the U.S.A. had been the largest iron ore producer, followed by the U.S.S.R., France, Sweden, the U.K., India, Canada and Chile. By 1979, the U.S.S.R. had become the largest ore producer of the world followed by Australia, Brazil, the U.S.A., China, Canada and India. Canada had moved up within the ranks of the iron ore suppliers in the world. The change is reflected in the sizeable Canadian balance of trade surplus attributable to the exports of iron ore products. In 1979, such exports exceeded imports by 43 million metric tons worth more than $Can. 1.1 billion. Ore imports may have affected the performance picture of the Canadian iron ore industry in 1977 and 1978, but not in 1979 when Canadian ore output rose dramatically.

The iron ore reserves of the world are larger than 200 billion metric tons of contained iron and they are going to rise. The U.S.S.R. is the most important resource holder in the world accounting 26.5 percent of the total, with Canada and Brazil sharing equally the same quantity as the U.S.S.R.; Australia (9.3%) and the U.S.A. (8.4%) are the other two main resource holders, while the share summarily held by India, China, Venezuela, France, Sweden and South Africa may just match the Canadian total of 13.5 percent.

Outside North America, investment in the expansion of the iron ore industry are considerable. Although the survey covered the main resource countries, it still had to remain incomplete, because only one third of the about 50 producing countries have been investigated.

By the year 1985 over 90 million metric tons of iron ore (metal content) will be added to world production capacities. World output potential would rise to 616,100,000 metric tons per year; this is over the 523,400,000 metric ton peak of 1976. Five years later annual capacities will have risen by a total of 162,100,000 to 685,500,000 metric tons. These incremental figures of metal content have been obtained by applying optimistic grade percentages to the expected ore capacities of the surveyed countries for which had been recorded such investments. It also includes annual standard additions of 4 million metric tons for the U.S.S.R. besides the Kostamus project.

On the base of these rough estimates the sources of additional supplies are:

| | 1985 (92.7 million m.t.) | 1989 (162.1 million m.t.) |
|---|---|---|
| Central and South America | 30.5% | 23.4% |
| Europe and U.S.S.R. | 34.0% | 32.6% |
| Africa | 11.5% | 18.9% |
| Asia | 16.4% | 16.2% |
| Australasia | 7.6% | 8.9% |

It also means that, if expressed in a straight line continuous function, annual additions to iron ore output up to 1983/1985 would run to 18.5 million metric tons while by 1989, even with major projects hopefully completed in Brazil and Africa, the annual increments would go down to 13.9 million metric tons.

The price of iron ore was on a declining trend until 1894 Hence, it has been rising, especially since 1945. Yet, it was only in the 1970s that this rise in the price of iron ore accelerated in an unprecedented manner.

The prices of pig iron and carbon steel plates behaved similarly with likewise fast upwards movements in the 1970s. It was interesting to note that it took almost 150 years - from the turn of the 18th centruy to the middle of the 20th century, for a previous historical high in that price to be broken. Most important, however, was the observation of a great stability of the prices of iron ore compared to price behaviour of both pig iron and carbon steel plates. These two variables did not only display larger swings but eventually rose about twice as fast as the price of iron ore.

The real (1979) price of iron ore will rise from $25.71/lt to $43.62/lt by the year 2000. At the end of the forecast period, it will stand at $51.03/lt; the rise up to the year 2000 means a 70 percent change in price (or cost) while by the year 2004 it will have about doubled.

Annual world iron ore production will rise from 538.7 million metric tons in 1980 to 946.4 million metric tons by 2000. Four years later, production is estimated to be 1.0 billion metric tons. This means that between 1980 and the years 2000 and 2004, annual iron ore output (metal content) will rise by 75.7 and 91.6 percent respectively. By the years 2000 and 2004 the cumulative totals of iron extracted from the earth since 1980 will amount to 15.5 and 19.5 million metric tons.

Crude steel production will rise from 735.8 million metric tons in 1980 to 1.19 billion and 1.28 billion metric tons by the years 2000 and 2004 respectively. When the future world productions of iron ore and crude steel are compared an implicitly greater reliance on iron ore than on secondary iron products (scrap) is revealed.

Finally, this forecast compares favourably with that undertaken by Dr. W. Malenbaum while the projection by the U.S.B.M. (1975) seems somewhat overstated.

The following conclusion may be drawn:

In essence, there is no shortage of iron but only one of the applications of human and non-human resources in the

extraction of iron ores. Should a deficiency of basic inputs for the iron and steel producers of the world materialize later in the 1980s the prices of final iron and steel commodities will rise such that the derived demand for iron ore will also increase and with it the predicted rise in the price of iron ore. Eventually this pressure will help mobilize capital and other resources for the extraction of iron ores. Unless large scale investments in this area can be secured by the middle of the 1980s a substantial shortfall in iron ore should be expected. The iron and steel scrap industry will only too rejoicingly oblige!

On the other hand, annual deficiencies of between 30 and 50 million metric tons of iron in ore form, by 1989-1990 will offer good opportunities for the large reserve holders of the world. Countries to take advantage of such opportunities should e.g. the U.S.S.R., Brazil, Canada, Australia, the U.S.A., India and countries on the African continent. However, the successful exploitation of such endeavours are subject to certain conditions. Since iron and steel producers are cost-efficiency conscious, it is clear that the rise in the costs of capital acquisition, labour, transportation, interest rates and fuel, especially under the sceptre of a world-wide oil cartel, will force these producers into the utilization of the cheapest ore resources of world when and wherever feasible. This would normally call for a priority of using the high-grade ores first, and that is why countries such as Brazil, Liberia,

Mauritania, Australia, Venezuela, Sweden, South Africa and India have moved into the forefront of suppliers. Only if steel producers attend carefully to all efficiency aspects on a world-wide scale will they be able to survive in a very competitive world market.

Consequently, the iron and steel producers are globally linked to a market. In their actions, however, the producers in the various countries are also subject to the widely differing policies of all types of authorities which intervene, for better or for worse, with the so-called 'optimal allocation of resources'. Be it for reasons of securing high levels of domestic employment or with the intent to improve the balance of payments - not to mention the monopolistic practices of certain countries - such measures do not fail to affect resource extraction accordingly. Varying taxation and subsidy policies among the countries of the world as well as responsible environmental policies in some countries and total disregard for them in others tend to shift the theatres of performance of this industry. This is especially true if governments which normally are incapable of affecting the market are plagued by myopic parochialism in their approaches towards the resource sectors. This is particularly true for the iron ore industry, which, through the world-wide abundance of the mineral, is much more vulnerable than other resource producers As, for instance, in the plantinum industry. If the degree of myopia is even changing unpredictably due to

inconsistencies in the views of government of the importance of such industries well-calculated investment projects may, in the final analysis, be causes for concern and disappointment and doomed in failure with huge capital losses involved. Worst of all, the iron ore that had been expected will not be forthcoming.

In countries, whose governments, provide incentives and subsidies, the opposite will occur. Therefore, whether Canada can take advantage of future opportunities in the iron ore field, when and if they occur, is not only a function of size of resources and their grades or of prices and costs of production, but also of the entire gamut of national and provincial policies responsible for the climate surrounding the iron ore industry.

Finally, it is necessary to point out that the demand and supply of iron ore for the world has been traced out in the econometric forecast until the year 2004. However, the investment activities in this field are merely open for assessment for a few number of years in the future, and it is only as the future unfolds itself that the actual decisions may be seen as facts. Therefore, any preview of what is in stock as regards investments in iron ore mining cannot be undertained beyond the 1980s.

NOTES

1 Scientific symbol Fe; atomic weight, 55.84, specific gravity 7.86; melting point, 1535°C; boiling point 2750°C.

2 F.L. Klinger, 'Iron Ore' Mineral Facts and Problems, 1975 U.S.B.M. (Washington, D.C., 1975) p. 525.

3 ibid.

4 Any encyclopedia will answer questions as to the wide use and application of iron. Also, for statistical purposes see: Metal Statistics, American Metal Market, A Fairchild Publication, Annual, Chapters on 'Steel'; also, esp. with respect to iron ore see: American Iron Ore Association, Iron Ore, Annual, Cleveland, Ohio.

5 The reader may obtain more pertinent information by consulting American Metal Market, op. cit., 1979, esp. p. 207 and 208.

6 Such a ratio behaves like a stochastic error term.

7 $$e = \frac{\text{relative change of ore produced}}{\text{relative change of steel}} = \frac{1008.0}{335.1} = 3.22$$

8 See: 'Technical Information Paper' No. 2, p. 5 and 6. Note also that the statistics reflect tonnage of ore produced and not the iron metal content. For a valid interpretation the assumption was made that Canadian iron ores are homogeneous regardless of their source of origin.

9 F.L. Klinger, loc. cit. p. 525.

10 ibid.

11 Not shown in Table 4; cf. 'Iron Ore', 'The Steel Industry Metal', M.A.R., 1980, p. 73.

12 ibid.

13 For a discussion of the concept of long-ton unit, see 'Technical Information Paper No. 1', p. 16.

14 Exports 1980:

| | | | |
|---|---|---|---|
| 251-04 | 3,372,010 | U.S.A. | 2,792,820 |
| 251-08 | 20,122,416 | Japan | 3,806,838 |
| | | Netherlands | 5,205,228 |
| | | U.S.A. | 3,712,627 |
| 251-12 | 15,492,717 | U.S.A. | 10,723,961 |
| | | U.K. | 2,043,668 |
| | | W. Germany | 1,137,124 |
| | | Netherlands | 1,108,835 |
| 251-16 | 6,934 | U.S.A. | |

Imports 1980:

| | | | |
|---|---|---|---|
| 251-20 | 5,874,839 | U.S.A. | 5,874,839 |
| | | Brazil | 221,994 |

Source: Statistics Canada, Exports by Commodities, Dec. 1980, Imports by Commodities, Dec. 1980.

15 One argument raised in context with the closure of the Moose Mountain operations has been that Canada imports iron ores because of a long-term contractual commitment. This point is not born out by the rise of imports, unless these contracts provide for a rising tonnage.

16 Klinger, ibid., p. 529, Table 1; and Duncan R. Derry, A Concise World Atlas of Geology and Mineral Deposits, Mining Journal Books (London, 1980), p. 96.

17 According to Strishkov, M.A.R. 1980, p. 595, the total reserves are 111 billion metric tons with an average grade of 34.8 percent iron; this would amount to 38.6 million metric tons. A quick check produces a result of 1,257,103 million metric tons of ore produced (metal content) in the U.S.S.R. since the survey of 1969.

U.N. Statistics

| | | |
|---|---|---|
| 1979 | | 149.742 million metric tons |
| 1978 | | 146.398 |
| 1977 | | 132.418 |
| 1976 | | 130.890 |
| 1975 | | 127.483 |
| 1974 | | 123.155 |
| 1973 | | 118.151 |
| 1972 | | 113.467 |
| 1971 | | 110.341 |
| 1970 | | 106.058 |
| 1970-1979 | Total | 1,257,103 |

Subtracting this total from 51.71 billion still leaves 50.45 billion metric tons in the ground in Soviet Russia. Similarly, these figures do not correspond to Klinger's short-run reserve of 28.1 billion metric tons for the year 1970.

According to Strishkov, loc. cit. IMMR, 1980, p. 207 (Table 5), and p. 208 (Table 6) production and exports of iron ore by the U.S.S.R. were as follows:

'000 Metric Tons

| Year | Production of Iron Ore 55 to 63% Fe | Exports of Iron Ores |
|---|---|---|
| 1974 | 224,831 | 43,300 |
| 1975 | 232,803 | 43,620 |
| 1976 | 239,110 | 43,120** |
| 1977 | 239,715 | 40,946** |
| 1978 | 244,000 | 42,000** |
| 1979 | 242,000 | 41,000** |

* based on Soviet sources

** estimated

Also Strishkov 'Soviet Union' M.A.R. 1980 p. 594, Table A, and p. 597, Table B.

18 Engineering and Mining Journal, January 1981, p.71.

19 M.A.R., 1980, p. 390, preliminary figures.

20 ibid.,(n. 11), supra, p. 79.

21 ibid., p. 391.

22 In 1974 a 40 mile pipeline was constructed in Mexico, while Brazil has had plans for a 210 mile long pipeline to be constructed in 1978.

23 Engineering and Mining Journal, March 1981, p. 225.

24 Cf. Table 11, where total reserves are listed as being 26.31 billion metric tons.

25 Engineering and Mining Journal, March 1981, p. 222.

26 The separate joint ventures with Spain, Italy and Japan respectively are not affected. Pellet capacity has now been reduced to 15 from 17 million metric tons; however, the six plants, i.e. two owned by CVRD and four joint ventures exported only 10 million metric tons in 1980 from Vitorio, capital of Espirito Santo, where the plants are located.

27 E. Schiller, 'Colombia', M.A.R. 1980, p. 405.

28 ibid.

29 Engineering and Mining Journal, May 1981, p. 167.

30 Manuel Rodrigues Lopez and D. Herminio Blanco Piñas, 'Spain' M.A.R. 1980, p. 564; note: average grade is 47% ranging from 41.2% to 56%; ibid.

31 ibid.

32 Strichkov, 'Soviet Union', M.A.R. 1980, p. 595.

33 Engineering and Mining Journal, January 1981, p. 69.

34 Finland has been a net importer of iron ore for a number of years; for instance: in 1963 Finland mined 232,000 metric tons of iron ore (metal content) and produced 308,000 metric tons of crude steel. In the year 1977, it produced 733,000 metric tons of iron ore and 2,196,000 metric tons of crude steel.

35 'Iron Ore', M.A.R. 1980, p. 75.

36 The first of its kind ran from 1976-1980, the second is presently in progress for the period 1980 to 1984. See: William C. Fairbairn, 'Liberia', M.A.R. 1980, p. 526.

37 ibid.

38 ibid.

39 World Bank: 25%; Foreign consortium: 40%; Suppliers' credits: 35%. Cf. Engineering and Mining Journal, January 1980, p. 82, which sets the cost at $200 million (unspecified).

40 Government of Senegal: 28.5%; BRGM: 23.8%; Kanematsu Gosho: 23.8%, and Krupp: 23.8%; see M.A.R. 1980, p. 529.

41 Table 5 sets the average of the delivered grade of iron ore at between 53 and 55 percent.

42 Algeria's ore consumption is about 1 million metric tons per annum; see IMMR 1980, p. 3.

43 Cf. M.A.R. 1980, p. 541. According to this report the rail line is to be 932 miles long.

44 Tazadit, F'derik, and Rouessa, operated by Complexe Minier du Nord, (Cominor). Originally, they were owned by Miferma which was in the hands of French, British, Italian and West German interests. The Mauritanian government held 5 percent of the equity at the time. A change in government brought ownership to a full 100 percent into the hands of the government in 1974. By 1979, the authorities again altered their holding requirement reducing it to 51 percent of the total and admitting 49 percent foreign, this time, Arabian interests; see 'Mauritania' M.A.R. 1980, p. 539.

45 This stage will be financed by the new shareholders of SNIM, and several international financial sources: World Bank, France's CCCE, the Kuwait Fund, the Arab Fund for Social and Economic Development, and the European Investment Bank.

46 Cf. M.A.R. 1980, p. 540 which considers the SAMIA a joint venture of SNIM and Kuwaitian interest with the output destined to go to Middle East countries.

47 A direct reduction steel plant with a capacity to produce one million metric tons of steel is being built at Aladja near Warri. Three rolling mills are planned by the government at Oshogbo, Jos and Katsina. Eventually, all these steel plants which are now under construction will produce 2.3 million metric tons of steel.

48 It is interesting to note that the new industrial policy of Angola is designed to attract foreign investment. This policy was drawn up by the late President Agostinho Neto. It has been supported by his successor, Eduardo Jose de Santos adopting the general principles of non-alignment and of the development of new and open relations to the West. See: Jack A. Scott, 'Nigeria', M.A.R. 1980, p. 505.

49 K.P. Wang, 'China', M.A.R. 1980, p. 442-445.

50 IMMR, 1979, 'India', p. 6-7; This figure is based on an ore content of 51 percent iron; there are about 17-30 billion metric tons of iron ore, hematite (61-62% Fe) accounting for 2/3 of this total and magnetite (26-35%) for 1/3. Proven hematite ore serves are:

| | |
|---|---|
| Chiria deposit | 1.97 |
| Donamali deposit | .159 |
| Manlangtoli deposit | .608 |
| Kiriburu deposit | .256 |
| Roughhat deposit | .962 |
| Dallirajhara deposit | .647 |
| These main deposits of | 4.602 account for 65.7% |

of a total of 7.0 billion.

Proven magnetite ore reserves including quarzite are:

Babadudan Hills (30% iron): 3.0-5.0 billion.

According to tests at Kudremukh, the Babadudan ore has been upgraded to an iron content of 66%!

51 G.R. Seshadri, 'India', M.A.R. 1980, p. 459-460.

52 Engineering and Mining Journal, January 1981, p. 71.

53 ibid. cf. for increases in cost: Engineering and Mining Journal, May 1981, p. 190.

54 IMMR, ibid.

55 T.F. Lanz, and D.J. Bath, 'Australia', M.A.R. 1980, p. 418.

56 Engineering and Mining Journal, ibid.

57 Engineering and Mining Journal, March 1981, p. 232.

58 ibid.

59 One has to bear in mind that Australia's iron ore production is most likely greater for the year 1980 than it was in 1979. E.g. The Robe River Iron consortium, although it closed down its pellet plants, increased its ore output by 9.5 to 14.88 million metric tons for that year.

60 ibid.

61 Computed at an exchange rate of $A 1.1055 for 1$ US.

62 Engineering and Mining Journal, January 1981, p. 71.

63 ibid., p. 148.

64 Note: Two standards of measurement have been utilized. Here, as well as in E.T. Willauer, 'Technical Information Paper, No. 3, p. 9 and 17, whereas in Technical Information No. 1, 'Metal Prices 1979', (H. Strauss), iron ore prices have been quoted in long-ton units; ibid. p. 17.

65 The Statistical Abstracts of the U.S.A., places these values for 1978 and 1979 at $22.30/lt and $24.75/lt respectively.

66 'Slower Growth Projected for Mining', Engineering and Mining Journal, January 1978, p. 63.

67 F.L. Klinger, loc. cit. (n. 2, supra), p. 543, Table 7.

68 Source: Horace T. Reno, and Donald H. Desy, "Iron and Steel", Mineral Facts and Problems, 1975, op. cit., p. 572, Table 12; and Wilfred Malenbaum, World Demand for Raw Materials in 1985 and 2000, Engineering and Mining Journal, Mining Information Services, McGraw-Hill (New York, N.Y., 1978), Table 5-1.1, p. 71.

69 1973: 0.7928%; 1985: 0.7978%; and 2000: 80.14%.

70 This possible opportunity for the scrap iron and steel industry would actually last longer than expressed by an optimistic message of Morton B. Plant, President of the Institute for Scrap Iron and Steel. He did forecast 'glamorous business in the early 1980s', for the iron and steel scrap industry due to the necessity 'to save energy'. He is a person who basically disregards economists' opinions who, - so he said - were 'gloom forecasters since I was a child'. American Metal Market, January 24, 1980.

# APPENDIX

TABLES A1 - A15

Table A1

Iron Ore NES, Incl. By-Prod. Iron Ore
(commodity 251-16)

| Year | Quantity (metric tons) Exports | Value ($'000) Exports |
|---|---|---|
| 1979 | 64,646 | 1,739 |
| 1978 | 289,244 | 10,207 |
| 1977 | 177,732 | 6,528 |

| | | |
|---|---|---|
| Exports | 1977 - U.S. | 100% |
| | 1978 - U.S. | 100% |
| | 1979 - U.S. | 99% |
| | Argentina | .004% |

Table A2

Iron Scrap
(commodity 251-29)

| Year | Quantity (metric tons) Exports | Imports | Balance | Value ($'000) Exports | Imports | Balance |
|---|---|---|---|---|---|---|
| 1979 | 140,483 | 309,033 | (-)168,550 | 11,384 | 25,959 | (-)14,575 |
| 1978 | 142,190 | 283,867 | (-)141,677 | 9,229 | 16,649 | (-) 7,420 |
| 1977 | 101,807 | 236,395 | (-)134,588 | 6,660 | 11,394 | (-) 4,734 |

| | | | | |
|---|---|---|---|---|
| Exports | 1977 - U.S. | 93% | Imports | 1977 - U.S. 99% |
| | 1978 - U.S. | 96% | | 1978 - U.S. 100% |
| | 1979 - U.S. | 93% | | 1979 - U.S. 99% |

Table A3

Steel Scrap
(commodity 251-40)

| Year | Quantity (metric tons) Exports | Imports | Balance | Value ($'000) Exports | Imports | Balance |
|---|---|---|---|---|---|---|
| 1979 | 857,239 | 737,508 | 119,731 | 88,855 | 68,738 | 20,117 |
| 1978 | 708,160 | 667,979 | 40,181 | 52,402 | 39,546 | 12,856 |
| 1977 | 571,138 | 347,583 | 223,555 | 34,347 | 18,352 | 15,995 |

| | | | | |
|---|---|---|---|---|
| Exports | 1977 - U.S. | 75% | Imports | 1977 - U.S. 99% |
| | Spain | 8% | | 1978 - U.S. 99% |
| | 1978 - U.S. | 66% | | 1979 - U.S. 99% |
| | Italy | 21% | | |
| | 1979 - U.S. | 63% | | |
| | Italy | 18% | | |
| | Turkey | 5% | | |

Table A4

Ferromanganese Incl. Spiegeleisen
(commodity 441-19)

| Year | Quantity (metric tons) | | | Value ($'000) | | |
|---|---|---|---|---|---|---|
| | Exports | Imports | Balance | Exports | Imports | Balance |
| 1979 | 12,043 | 83,679 | (-)71,636 | 2,830 | 45,282 | (-)42,452 |
| 1978 | 19,924 | 26,809 | (-) 6,885 | 5,987 | 14,139 | (-) 8,152 |
| 1977 | 23,105 | 29,364 | (-) 6,259 | 8,019 | 13,824 | (-) 5,805 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Exports | 1977 - | U.S. | 85% | Imports | 1977 - | S. Africa 28% |
| | | Venezuela | 15% | | | U.S. 27% |
| | 1978 - | U.S. | 99% | | | Norway 18% |
| | 1979 - | U.S. | 99% | | 1978 - | S. Africa 44% |
| | | | | | | Norway 26% |
| | | | | | | U.S. 22% |
| | | | | | 1979 - | S. Africa 26% |
| | | | | | | U.S. 23% |
| | | | | | | Brazil 13% |

Table A5

Ferrosilicon
(commodity 441-39)

| Year | Quantity (metric tons) | | | Value ($'000) | | |
|---|---|---|---|---|---|---|
| | Exports | Imports | Balance | Exports | Imports | Balance |
| 1979 | 40,733 | 19,800 | 20,933 | 21,962 | 14,044 | 7,918 |
| 1978 | 60,147 | 10,482 | 49,665 | 27,053 | 7,890 | 19,163 |
| 1977 | 45,491 | 9,106 | 36,385 | 17,225 | 5,552 | 11,673 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Exports | 1977 - | U.S. | 70% | Imports | 1977 - | U.S. 85% |
| | | W. Germany | 19% | | | France 5% |
| | 1978 - | U.S. | 80% | | 1978 - | U.S. 83% |
| | | Japan | 9% | | | Sweden 6% |
| | | W. Germany | 8% | | 1979 - | U.S. 90% |
| | 1979 - | U.S. | 77% | | | Norway 7% |
| | | Japan | 14% | | | |

Table A6

Ferro Alloys NES
(commodity 441-99)

| Year | Quantity (metric tons) Exports | Imports | Balance | Value ($'000) Exports | Imports | Balance |
|---|---|---|---|---|---|---|
| 1979 | 7,079 | 7,073 | 6 | 8,298 | 16,108 | (-) 7,810 |
| 1978 | 9,878 | 17,357 | (-) 7,479 | 4,422 | 26,960 | (-)22,538 |
| 1977 | 1,799 | 17,115 | (-)15,316 | 2,121 | 22,157 | (-)20 036 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Exports | 1977 - | U.S. | 76% | Imports | 1977 - | Greece 54% |
| | | U.K. | 17% | | | U.S. 18% |
| | 1978 - | U.S. | 86% | | | Brazil 10% |
| | | U.K. | 12% | | | France 7% |
| | 1979 | U.S. | 49% | | 1978 - | Greece 58% |
| | | U.K. | 33% | | | U.S. 16% |
| | | Neth. | 14% | | | Dominican Rep. 13% |
| | | | | | | France 8% |
| | | | | | 1979 - | U.S. 58% |
| | | | | | | France 25% |
| | | | | | | Brazil 15% |

Table A7

Pig Iron
(commodity 442-19)

| Year | Quantity (metric tons) Exports | Imports | Balance | Value ($'000) Exports | Imports | Balance |
|---|---|---|---|---|---|---|
| 1979 | 255,522 | 9,913 | 245,609 | 47,874 | 2,130 | 45,744 |
| 1978 | 544,713 | 2,556 | 542,157 | 92,150 | 521 | 91,629 |
| 1977 | 505,275 | 11,913 | 493,362 | 83,649 | 2,268 | 81,381 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Exports | 1977 - | U.S. | 41% | Imports | 1977 - | U.S. 71% |
| | | Neth. | 33% | | | Brazil 29% |
| | 1978 - | U.S. | 42% | | 1978 - | Brazil 86% |
| | | Neth. | 23% | | | U.S. 14% |
| | | Japan | 20% | | 1979 - | U.S. 78% |
| | 1979 - | U.S. | 54% | | | Brazil 21% |
| | | Neth. | 16% | | | |

Table A8

Iron and Steel Powder
(commodity 442-27)

| Year | Quantity (metric tons) Imports | Value ($'000) Imports |
|---|---|---|
| 1979 | 4,641 | 3,673 |
| 1978 | 4,006 | 2,559 |
| 1977 | 4,648 | 2,449 |

Imports 1977 - U.S. 99%
1978 - U.S. 99%
1979 - U.S. 97%

Table A9

Sponge Iron and Primary Iron NES
(commodity 442-29)

| Year | Quantity (metric tons) | | | Value ($'000) | | |
|---|---|---|---|---|---|---|
| | Exports | Imports | Balance | Exports | Imports | Balance |
| 1979 | 138,326 | 5,227 | 133,099 | 32,655 | 2,820 | 29,835 |
| 1978 | 57,401 | 4,026 | 53,375 | 23,607 | 1,769 | 21,838 |
| 1977 | 51,908 | 3,969 | 47,939 | 18,746 | 1,269 | 17,477 |

Exports 1977 - U.S. 93%
1978 - U.S. 95%
1979 - Spain 46%
U.S. 41%

Imports 1977 - U.S. 99%
1978 - U.S. 99%
1979 - U.S. 82%
France 16%

Table A10

Ingots, Carbon Steel
(commodity 442-30)

| Year | Quantity (metric tons) Imports | Value ($'000) Imports |
|---|---|---|
| 1979 | 67,827 | 16,118 |
| 1978 | 35,849 | 5,944 |
| 1977 | 51,160 | 7,674 |

Imports 1977 - Brazil 97%
1978 - U.S. 54%
Brazil 46%
1979 - U.S. 100%

Table A11

Steel Ingots
(commodity 442-49)

| Year | Quantity (metric tons) Exports | Value ($'000) Exports |
|---|---|---|
| 1979 | 19,972 | 4,562 |
| 1978 | 34,188 | 5,862 |
| 1977 | 88,777 | 11,871 |

Exports 1977 - U.S. 100%
1978 - U.S. 100%
1979 - U.S. 100%

Table A12

Ingots, Alloy Steel
(commodity 442-55)

| Year | Quantity (metric tons) Imports | Value ($'000) Imports |
|---|---|---|
| 1979 | 4,415 | 3,082 |
| 1978 | 1,484 | 1,247 |
| 1977 | 1,067 | 967 |

Imports 1977 - U.S. 99%
1978 - U.S. 100%
1979 - U.S. 99%

Table A13

Blooms Billets and Slabs Carbon Steel
(commodity 442-60)

| Year | Quantity (metric tons) Imports | Value ($'000) Imports |
|---|---|---|
| 1979 | 95,566 | 28,609 |
| 1978 | 5,073 | 1,632 |
| 1977 | 3,641 | 1,044 |

Imports 1977 - U.S. 61%
S. Africa 22%
U.K. 16%
1978 - U.K. 38%
U.S. 29%
S. Africa 25%
1979 - U.S. 98%
S. Africa 1%

Table A14

Blooms Billets and Slabs Alloy Steel
(commodity 442-90)

| Year | Quantity (metric tons) Imports | Value ($'000) Imports |
|---|---|---|
| 1979 | 12,431 | 10,953 |
| 1978 | 11,509 | 7,083 |
| 1977 | 5,456 | 3,368 |

Imports 1977 - U.S. 64%
U.K. 34%
1978 - U.S. 67%
U.K. 29%
1979 - U.S. 55%
U.K. 44%

Table A15

Blooms Billets and Slabs Steel
(commodity 442-99)

| Year | Quantity (metric tons) Exports | Value ($'000) Exports |
|---|---|---|
| 1979 | 100,769 | 26,145 |
| 1978 | 245,282 | 52,024 |
| 1977 | 151,001 | 26,852 |

Exports - 1977 - U.S. 70%
Venezuela 20%
1978 - S. Korea 31%
U.S. 28%
Venezuela 18%
1979 - U.S. 39%
Malaysia 20%
S. Korea 15%